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The Badminton Library

OF

SPORTS AND PASTIMES

EDITED BY

ALFRED E. T. WATSON

MOTORS

AND

MOTOR-DRIVING

HER MAJESTY THE QUEEN IN HER ELECTRIC CAR
AT SANDRINGHAM

(*After a photograph taken by H.R.H. Princess Victoria*)

MOTORS AND MOTOR-DRIVING

BY

SIR ALFRED C. HARMSWORTH, BART.

WITH CONTRIBUTIONS BY

THE MARQUIS DE CHASSELOUP-LAUBAT
THE HON. JOHN SCOTT-MONTAGU, M.P., SIR DAVID SALOMONS, BART.
R. J. MECREDY, THE HON. C. S. ROLLS, HENRY STURMEY
C. L. FREESTON, J. ST. LOE STRACHEY
THE RIGHT HON. SIR J. H. A. MACDONALD
AND OTHERS

WITH ILLUSTRATIONS BY
H. M. BROCK, H. TRINGHAM, AND FROM PHOTOGRAPHS

Third Edition

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BADMINTON

THE BADMINTON LIBRARY

May 1885.

A FEW LINES only are necessary to explain the object with which these volumes are put forth. At the time when the Badminton Library was started no modern encyclopædia existed to which the inexperienced man, who sought guidance in the practice of the various British Sports and Pastimes, could turn for information. Some books there were on Hunting, some on Racing, some on Lawn Tennis, some on Fishing, and so on ; but one Library, or succession of volumes, which treated of the Sports and Pastimes indulged in by Englishmen—and women—was wanting. The Badminton Library was produced to supply the want. Of the imperfections

which must be found in the execution of such a design we are conscious. Experts often differ. But this we may say, that those who are seeking for knowledge on any of the subjects dealt with will find the results of many years' experience written by men who are in every case adepts at the Sport or Pastime of which they write. It is to point the way to success to those who are ignorant of the sciences they aspire to master, and who have no friend to help or coach them, that these volumes are written.

To those who have worked hard to place simply and clearly before the reader that which he will find within, the best thanks of the Editor are due. That it has been no slight labour to supervise all that has been written he must acknowledge ; but it has been a labour of love, and very much lightened by the courtesy of the Publisher, by the unflinching, indefatigable assistance of the Sub-Editor, and by the intelligent and able arrangement of each subject by the various writers, who are so thoroughly masters of the subjects of which they treat. The reward we all hope to reap is that our work may prove useful to this and future generations.

BEAUFORT.

PREFACE

IN a history of the origin and compilation of the BADMINTON LIBRARY prefaced to 'The Poetry of Sport,' I wrote, 'With this volume, the twenty-eighth of the series, the BADMINTON LIBRARY comes to an end, at least so far as is at present contemplated'; but noting how, since the issue of 'Hunting' in 1885, Golf and Cycling had attained such extraordinary prominence and popularity, I added, 'Who can say what sport may not spring up and take the public fancy? If any such does arise, a volume about it will doubtless be written.' Motoring—for the verb will have to be accepted and recognised—is such a sport, or, if the description be not admitted on all hands, is at any rate, for reasons set forth in the following chapters, sufficiently near to sport to require inclusion; and therefore no excuse seems necessary for this book. That automobilism is by no means a new idea the Marquis de Chasseloup-Laubat shows in his contribution; indeed,

he traces the origin of the movement to the year 1769, and gives a picture of a steam coach which ran daily from Paddington to Harrow as long ago as 1833. It is only within the last two or three years, however, that any sustained attempt has been made to introduce motor-cars into this country, and to employ them extensively as pleasure vehicles and for practical purposes.

The movement was exhibiting such vigour that a Badminton book became inevitable ; but it could scarcely have appeared so soon had it not been for the initiative and energy of an enthusiast, Mr. Alfred Harmsworth, one of the leading pioneers of automobilism in England, for whose invaluable assistance the Editor and Publishers cannot make sufficient acknowledgment. He is to a great extent responsible for the present volume, of the completeness of which it is not for us to speak, though we confidently anticipate the verdict of critics and of readers. The heartiest recognition must also be given to the untiring aid of Mr. Claude Johnson, Secretary of the Automobile Club, who has probably done more than any other man towards helping to rescue what must assuredly become a great British industry from foreign hands. Mr. Harmsworth and Mr. Johnson were fortunately able to secure the hearty co-operation of the Automobile Club. The

various chapters have been read before and exhaustively discussed by the members, to whom are due the thanks of the compilers and likewise of all who may benefit by the varied contents of the work ; nor must an expression of gratitude be omitted to the designers and makers of cars, English and foreign, who have so kindly furnished particulars, photographs and drawings.

As far as possible an endeavour has been made to avoid mentioning the names of particular constructors ; where such mention was unavoidable, it should not be understood as suggesting that in the opinion of the writer the cars manufactured by them are necessarily the best ; nor, on the other hand, must it be supposed that because various cars are not included, anything in the nature of adverse criticism is implied. The industry is being pursued with such great activity that to discuss every notable make and invention was impossible within the prescribed limits of the volume.

ALFRED E. T. WATSON

April 1902

NOTE TO THE THIRD EDITION

THIS edition has been revised throughout and illustrations of the latest types of cars have replaced some of those used in former editions. Chapters on 'Motor Cars for Men of Moderate Means' and 'The Gordon Bennett Race of 1903' have been included, and the full text of the new Motor Laws is given. The latest mechanical and ignition devices are described and illustrated, and the whole work has been brought up to date.

June 1904

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CHAPTER I

A SHORT HISTORY OF THE MOTOR-CAR

By the Marquis de Chasseloup-Laubat

When I was first invited to write a brief History of the Motor-Car, I at once realised that I could not do so without repeating much which was contained in an article entitled 'Recent Progress of Automobilism in France,' which I wrote for the 'North American Review' in September 1899.[1]

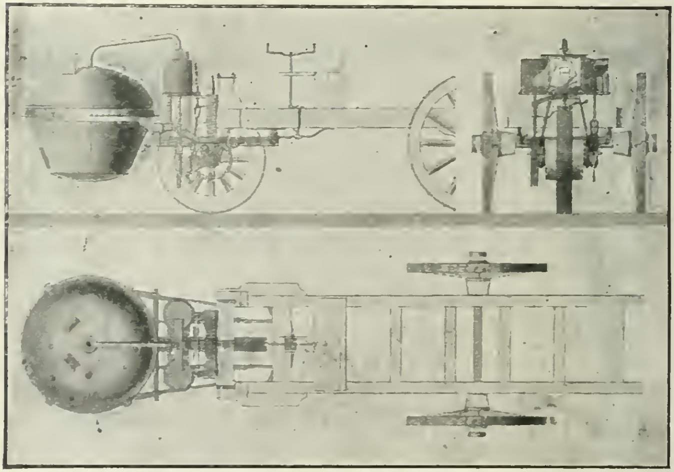
It is more than a century since, in 1769, automobilism was born in France, with the steam carriage of Cugnot. This vehicle was of a crude, rudimentary, and incomplete construction. The ideas of Cugnot were an entire century in advance of the mechanical means by which they could be realised.

The attempt led to no satisfactory results. Everything was defective—motive-power, steering, control. Nevertheless, the carriage ran, and ran so well, they say, that it broke down the enclosure of the ground on which it was tried. It is an incontestable fact that Cugnot is the inventor of automobile locomotion, and that the honour of first having imagined and realised a new method of transport, destined to play an important part in the welfare of many lands, belongs to him.

[1] The proprietors of that publication have been good enough to consent to my making use of portions of my article, and I take this opportunity of expressing my appreciation of their courtesy.

At the end of the eighteenth and the beginning of the nineteenth century, the great wars of American Independence, of the First Republic, and of the First Empire turned the spirit of France aside from new effort in the way of any kind of locomotion.

It was in England, towards the third decade of the nineteenth century, that we saw the idea of Cugnot reappear. The same impulse which moved English engineers to build railroads in



Elevation and Plan of N. J. Cugnot's Steam Car, 1770

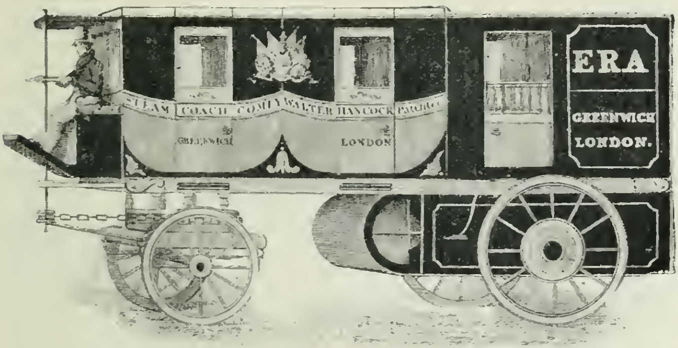
order to free the great industrial centres from the economic tyranny of those who constructed canals, urged them to study methods of automobile locomotion on highways. That is to say, in its inception, automobile locomotion was considered as an auxiliary to the railroad, which it really is.

Unfortunately, the promoters of new railway lines did not at all understand the respective spheres of action of the machine on the rail and the machine on the road. They took umbrage at automobile locomotion, and, since they had much capital

and influence at their disposal, they secured a law from the English Parliament which effectually killed automobile locomotion. It ordained that a man carrying a red flag by day, or a red lantern by night, must be kept a hundred yards in advance of every automobile vehicle.

The report of the Select Committee of the House of Commons which was published in 1831 is extremely instructive, and contains the following remarkable paragraphs :—

> These inquiries have led the Committee to believe that the substitution of inanimate for animal power, in draught on common



Hancock's Steam Coach 'Era,' 1833

> roads, is one of the most important improvements in the means of internal communication ever introduced. Its practicability they consider to have been fully established; its general adoption will take place more or less rapidly, in proportion as the attention of scientific men shall be drawn by public encouragement to further improvements.
>
> Many circumstances, however, must retard the general introduction of steam as a substitute for horse-power on roads. One very formidable obstacle will arise from the prejudices which always beset a new invention, especially one which will at first appear detrimental to the interests of so many individuals.
>
> Tolls to an amount which would utterly prohibit the introduc-

tion of steam-carriages have been imposed on some roads ; on others, the trustees have adopted modes of apportioning the charge, which would be found, if not absolutely prohibitory, at least to place such carriages in a very unfair position as compared with ordinary coaches.

It appears from the evidence that the first extensive trial of steam as an agent in draught on common roads was that by Mr. Gurney, in 1829, who travelled from London to Bath and back in his steam-carriage.[1] He states that, although a part of the machinery which brings both the propelling wheels into action, when the full power of the engine is required, was broken at the onset, yet that on his return he performed the last eighty-four miles, from Melksham to Cranford Bridge, in ten hours, including stoppages.

The committee have also examined Messrs. Summers and Ogle, Mr. Hancock, and Mr. Stone, whose steam carriages have been in daily use for some months past on common roads.

Besides the carriages already described, Mr. Gurney has been informed that from twenty to forty others are being built by different persons, all of which have been occasioned by his decided journey in 1829.

Much, of course, must remain to be done in improving their efficiency ; yet Mr. Gurney states that he has kept up steadily the rate of twelve miles per hour ; that the extreme rate at which he has run is between twenty and thirty miles per hour.

Mr. Hancock reckons that with his carriage he could keep up a speed of ten miles per hour, without injury to the machine.

Mr. Ogle states : 'That his experimental carriage went from London to Southampton in some places at a velocity of from thirty-two to thirty-five miles per hour.

'That they have ascended a hill rising one in six at sixteen and a half miles per hour, and four miles of the London Road at the rate of twenty-four miles and a half per hour, loaded with people.

'That his engine is capable of carrying three tons weight in addition to its own.'

Mr. Summers adds : 'That they have travelled in the carriage

[1] The Gurney steam coach was extremely interesting. It possessed: (1) A water-tube boiler analogous to the Thorneycroft boiler, in which the circulation was remarkable. (2) The pressure was considerable (5 kilos per sq. centimetre).

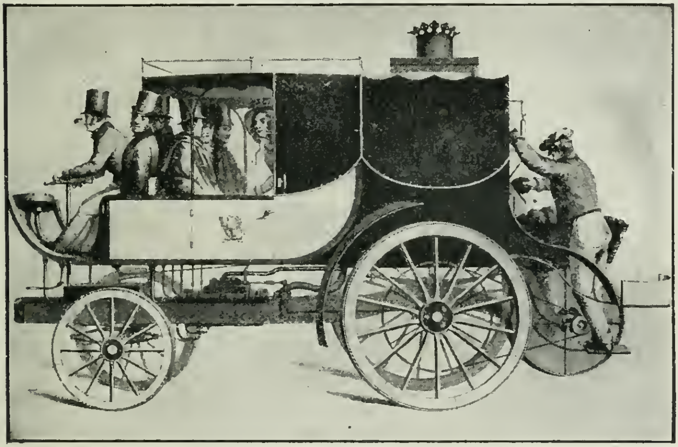
at the rate of fifteen miles per hour, with nineteen persons on the carriage up a hill one in twelve.

'That he has continued for four hours and a half to travel at the rate of thirty miles per hour.

'That he has found no difficulty in travelling over the worst and most hilly roads.'

Mr. James Stone states that 'thirty-six persons have been carried on one steam-carriage.

'That the engine drew five times its own weight nearly, at the rate of from five to six miles per hour, partly up an inclination.'



Squire and Macerone Steam Coach, 1833

Ran daily from Paddington to Edgware and Harrow. Average speed, fourteen miles per hour. Speed on level twenty miles per hour. Cost of coke, 3*d.* to 4*d.* per mile.

They have annexed a list of those local acts in which tolls have been placed on steam, or mechanically propelled carriages.

Mr. Gurney has given the following specimens of the oppressive rates of tolls adopted in several of these acts. On the Liverpool and Prescot Road, Mr. Gurney's carriage would be charged 2*l.* 8*s.*, while a loaded stage coach would pay only 4*s.* On the Bathgate Road the same carriage would be charged 1*l.* 7*s.* 1*d.*, while a coach drawn by four horses would pay 5*s.* On the Ashburnham and Totnes Road, Mr. Gurney would have to pay 2*l.*,

while a coach drawn by four horses would be charged only 3*s*. On the Teignmouth and Dawlish Roads the proportion is 12*s*. to 2*s*.

The trustees of the Liverpool and Prescot Road have already obtained the sanction of the legislature to charge the monstrous toll of 1*s*. 6*d*. per 'horse-power,' as if it were a national object to prevent the possibility of such engines being used.

Sufficient evidence has been adduced to convince your Committee :—

1. That carriages can be propelled by steam on common roads at an average rate of ten miles per hour.

2. That at this rate they have conveyed upwards of fourteen passengers.

3. That their weight, including engine, fuel, water, and attendants, may be under three tons.

4. That they can ascend and descend hills of considerable inclination with facility and safety.

5. That they are perfectly safe for passengers.

6. That they are not (or need not be, if properly constructed) nuisances to the public.

7. That they will become a speedier and cheaper mode of conveyance than carriages drawn by horses.

8. That, as they admit of greater breadth of tyre than other carriages, and as the roads are not acted on so injuriously as by the feet of horses in common draught, such carriages will cause less wear of roads than coaches drawn by horses.

9. That rates of toll have been imposed on steam carriages which would prohibit their being used on several lines of road, were such charges permitted to remain unaltered.

The Committee of 1831 made recommendations as to a Bill to regulate the tolls to be charged for mechanical vehicles and to prevent the imposition of exaggerated tolls. The recommendations, however, were not adopted, and the use of steam vehicles on the road consequently became practically impossible, although Hancock had considerably improved on Gurney's carriage, and up to 1836 was running highly successful vehicles on the road. After 1836 inventors from time to time came forward with improved road carriages, but owing to restrictive legislation they could not be put to any practical use.

GOLDSWORTHY GURNEY'S STEAM COACH. 1833. COKE FUEL

From an old Print

The consequences of this legislation were not long delayed. Automobile locomotion disappeared. Yet English builders of that period had already realised some excellent mechanical features. Certain among them had striking and remarkable schemes in regard to boilers, and had conceived extremely interesting 'water-tube boilers.' The boilers which my friends Normand and Thorneycroft to-day place on their torpedo-boats and torpedo-boat destroyers possess all the theoretical characteristics of certain apparatus conceived half a century ago.

Mr. Onésime Pecqueur, manager of the works connected with the Conservatoire for Arts and Inventions in France, designed in 1827 two very remarkable devices:

(*a*) The application of a differential gear to driving-wheels.

(*b*) The abolition of a forecarriage for steering-wheels replaced by the introduction of an axle fitted with two vertical pivots; the wheels pivoting separately on each, and being kept parallel with one another by a connecting-rod.

It is impossible not to notice how very much this invention has controlled the fundamental principles in the construction of automobiles.

It is no exaggeration to say that without these two very important devices, the automobile would not, at the present time, occupy the very prominent and progressive position it does.

In 1873 the firm of Léon Bollée commenced the construction of their vehicles, which attracted so much attention at the Universal Exhibition of 1878 in Paris.

At this period one of the most remarkable carriages was a Victoria weighing approximately $3\frac{1}{2}$ tons, including its complement of 8 passengers, 390 litres of water, and 300 kilos of coal. The effectual horse-power varied from 8 to 20 h.-p.; the greatest speed obtainable was about 40 kilometres per hour. The design of the vehicle was well proportioned and carried out. The transmission to the driving-wheels was effected by

two chains and an intermediary shaft. The steering of the car was obtained by the revolving of the front wheels on two pivots set at an angle, giving a dish to the wheels.

The Bollée company constructed about this period many equally interesting cars possessing speed-changing devices. Since then the firm have built very many interesting cars of various designs, but a full description of these would take up too much time and space. Suffice it to say, however, these cars were as well constructed as designed, and that many firms have between then and now constructed cars far inferior to those of Léon Bollée.

In France, about 1885, the automobile vehicle was again in evidence, and attracted attention. At that time the Comte de Dion, at Paris, also constructed steam vehicles which ran in a satisfactory way. Then Serpollet devised his instantaneous vaporisation boilers, which reduce to a minimum the chances of danger, so far as steam engines are concerned.

After that time, automobile locomotion became a subject of talk, but the appearance in 1889 of a petroleum motor, with quaternary explosion features, gave matters an impulse which promises continuance.

In 1894, the 'Petit Journal' asked M. Pierre Giffard to organise the first meeting of automobile vehicles. It took place between Paris and Rouen, with a stop at Mantes. Although the design of the promoters was not that the vehicles should be run with a view to testing speed, the event from the very outset took on the character of a race. The Dion and Bouton steam carriage won the race, making the run at a mean velocity of about twelve miles an hour.

This was a sturdy little four-wheeler, on the back of which rested the pole-bolt of an ordinary carriage, the fore-part of which had been removed. This constituted a six-wheeled affair, remarkably supple and manageable, in spite of its length. The vehicle, empty, weighed 1·4 ton; loaded 2·25 tons, and could develop fifteen horse-power. The two front wheels, steering-wheels, were rubber-tyred; the rear wheels, driving-

wheels, iron-tyred. This motor had the interesting arrangements of the Dion carriage—that is, the use of a Cardan joint as a substitute for the Galle chain, and the movement of the wheel by means of a drilled nave.

Almost all the other vehicles were driven by Daimler petroleum motors. The vehicles of the firm Panhard and Levassor, which controls the Daimler patents in France, had at that time the same principal characteristics as they present

Eckstein's Biographischer Verlag, Berlin

G. Daimler

to-day, which have been generally adopted. The motor maintained a fairly constant velocity of 750 revolutions; it acted on the drive-wheels situated at the back by means of a friction cone, a series of variable gears, a differential and a Galle chain; the steering-wheels were in front. The four-seated carriage weighed about a ton.

These carriages, as also the Peugeot petroleum vehicles, the motors of which were built by Panhard and Levassor,

worked with remarkable regularity, which, on the whole, demonstrated to those familiar with mechanics what a future there is in store for the petroleum carriage.

Though this first effort was attended with considerable success, the promoters of new methods of locomotion knew that much more remained to be accomplished. On November 18th, 1894, a most important meeting was held at the residence

Daimler Quadricycle, 1889, with Wilhelm Maybach and Paul Daimler

of M. de Dion, one which marked the beginning of an era of great development of automobiles in France. Those present at the meeting were Messrs. Baron de Zuylen, the Count de Dion, the Marquis de Chasseloup-Laubat, the Count de Chasseloup-Laubat, P. Gauthier, Ravenez, Peugeot, Levassor, Serpollet, Dufayel, Lavallette, Recoppé, Roger, Menier, de Place, Giffard, Emile Gauthier, Meillan, Nansouty, and Moreau.

It was decided at this meeting that, in the month of June of the following year, there should be a great race from Paris to Bordeaux and back (732 miles); that the carriages were to perform the whole distance in one trip; and that repairs were to be made only by such means as could be carried. The contestants, according to the formula adopted, were to procure *en route* nothing but 'entertainment for man and machine.' This was, therefore, a race and nothing but a race.

In a test of this kind it was, as a matter of course, extremely difficult to establish a method of competing which should be at all logical and satisfactory. The elements entering into an appreciation of the merits and faults of automobile carriages are so complex, that up to the present time the most competent specialists consider it almost impossible to establish a general formula for the classification of contestants. It was hence resolved to adhere to the course, since a test of speed, so long and so hard, would of itself eliminate any vehicle presenting the slightest flaw or insufficiency of construction.

These provisions have been completely realised, and to-day a very long and a very hard course is the most assured means of testing a vehicle.

During several months the committee did considerable work; for it was not only necessary to collect funds, but also to elaborate a set of regulations, and to obtain from the proper authorities the permission to make such trials of speed on the various sections of the route. In this arduous task the committee was most efficiently assisted by M. Marcel Desprez, Member of the Institute; M. Georges Berger, Deputy of the Seine; and especially by M. Michel Lévy, Engineer-in Chief of Bridges and Roads. Thanks to the efforts of the Committee, the whole matter was organised in spite of a multiplicity of difficulties. Numerous participants arrived; among them it gives me pleasure to note two Americans—Mr. Gordon Bennett and Mr. Vanderbilt.

During the early part of June, when all was ready, the vehicles were for several days placed on view in a permanent

public exhibition, which attracted much notice. On the 11th of June, at nine o'clock, all the contestants were gathered in Paris, about the Arc de Triomphe. They started in procession, with no attempt at speed, toward Versailles, where the test was to begin. About eleven o'clock all the carriages lined up on the Place d'Armes at Versailles in front of the great château, according to their order of starting, as determined by lot. I verified rapidly all the marks which I had made during the exhibition by means of the stamp with which the Committee had entrusted me. I stamped also all the spare movables carried by the vehicles. Finally, at 12.5 noon, I gave the signals for starting, two minutes apart. This race, favoured by splendid weather, was a success and created much sensation.

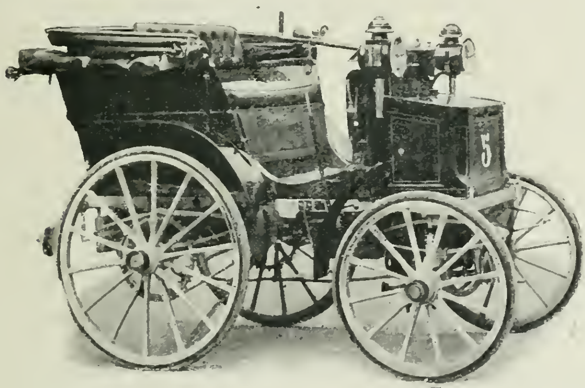
Thanks to the co-operation of local authorities, of the Touring Club of France, of the Bicycle Association, and the instructions prepared by M. Varennes, there was not the least accident to any of the riders ; all went well. The registration, both at fixed points and moving with the race, worked perfectly ; and, on the other hand, the minute verifications of the marks of my stamp showed accurately that the contestants had really accomplished the task 'by their own means.'

M. Levassor returned to Paris, Porte Maillot, June 13, 1895, at 12.57.30, thus accomplishing the formidable course of 732 miles (Versailles-Bordeaux-Versailles-Paris) in 48 hours and 48 minutes. He supervised the machine himself constantly, except when ascending an occasional incline, when the rate of speed was comparatively slow, and then he had entrusted the lever to his mechanic. M. Levassor remained on his machine about fifty-three hours, and nearly forty-nine of these on the run. Yet he did not appear to be over-fatigued ; he wrote his signature at the finish with a firm hand ; we lunched together at Gillet's, at the Porte Maillot ; he was quite calm ; he took with great relish a cup of bouillon, a couple of poached eggs, and two glasses of champagne ; but he said that racing at night was dangerous, adding that having won he had the

right to say such a race was not to be run another time at night.

The general mean of his velocity was 19·91 miles an hour; the maximum was eighteen and a half miles an hour, between Orleans and Tours.

The vehicle which had accomplished this marvellous record without a single break-down or any stops (except those required to take in water and petroleum and one stop for cleaning, of about a quarter of an hour, near Bordeaux), weighed 11·87 cwt. without supplies or the weight of the two



'No. 5.' Winner of the Paris-Bordeaux Race, 1895, driven by M. Levassor
(Four h.-p. Panhard and Levassor)

men riding. It had three speeds, six, twelve and a half, and eighteen and a half miles an hour, the normal number of revolutions being 750. The motor, a new type of 'Phœnix' built by M. Levassor, was a Daimler, modified and much perfected. The Levassor carriage, like all the swift carriages engaged in this race, was mounted on solid rubber tyres.

A steam carriage, by Dion and Bouton, of about fifteen horse-power, which had been making between thirty and thirty-eight miles an hour on test, kept the lead to near Vouvray, on the banks of the Loire, where a break-down in the shafting

threw it out of the race. At that moment, in spite of losses of time, occasioned by the cleaning of gratings and the defective organisation of relays, where water and coke had to be taken on, this vehicle was a score of minutes ahead of M. Levassor's carriage. The first steam road-carriage of M. de Dion was probably, until quite recently, the most rapid in existence. After having undergone some modifications and improvements, it was purchased by M. Michelin, a large manufacturer of pneumatics, and it continued for some time one of the swiftest and most stable in the maintenance of velocity. It weighs a little less than two tons, and with its twelve to fifteen horse-power easily and without strain makes thirty to thirty-eight miles an hour on the level.

Other carriages of Panhard and Levassor and of Peugeot likewise made good records.

The characteristic feature of the race of 1895 is the triumph of petroleum over steam. I gave the signal for departure at Versailles to fifteen petroleum and to six steam vehicles; we noted the return to Paris of eight petroleum vehicles and of one solitary steam carriage. This latter was the heavy omnibus by Bollée, constructed and run by those able engineers of Mans, who covered the course in spite of numerous break-downs, thanks to extraordinary physical endurance, and to a mechanical skill worthy of their excellent reputation.

The only electric vehicle entered in this race was constructed by M. Jeantaud, the eminent builder, who has since then made a speciality of electric carriages. It was a remarkable piece of machinery, especially for that epoch. But owing to the warping of the axle of one of the front wheels, due to a shock, he could not cover the route swiftly enough to utilise the relays of storage batteries which he held in readiness along the line

After having distributed the prizes, and made its report as a whole, the committee of the Paris-Bordeaux race, on my proposition, declared itself a permanent organisation, designed to give to the automobile industry a rallying centre and

encouragement based on conditions of competency and impartiality.

Some months later, MM. de Dion and de Zuylen took the initiative in changing the permanent commission into a sub-committee, adjunct of a society for the encouragement of automobile locomotion; thus the Automobile Club was born, which, in three years and a half, had grown, as to the number of its members, from about fifty to nearly two thousand; and now (January 1902) has over two thousand members. This Club, by reason of its large pecuniary resources, and also of the liberal and scientific spirit which animates the encouragement it gives in every way to the new industry, is certainly to-day one of the most useful and commendable institutions in France.

The Automobile Club of France, for which we have selected the abbreviation 'A. C. F.,' resolved to organise a race from Paris to Marseilles and back for September 24, 1896. This course, 1,061 miles in length, could certainly have been covered in a single trip by machines with relays of men; but the incontestable danger which a night run at full speed involves, led the committee to adopt the principle, which has since been followed, of a test by stages, so regulated that vehicles shall not be obliged to run by night save in cases of long delays due to breakdowns on the road.

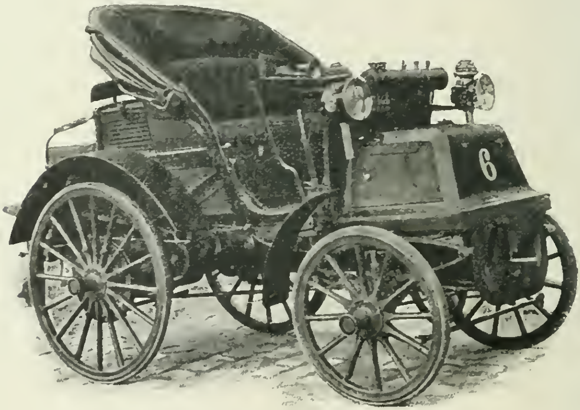
It was decided that the start should be made at Versailles, and that the course should be divided into ten stages: Auxerre, Dijon, Lyons, Avignon, Marseilles, Avignon, Lyons, Dijon, Sens, Paris. In each of these towns the vehicles were to be put up in a park under surveillance; the replacing of broken parts was prohibited, but ordinary repairs could be made by whatever means came to hand. Of the thirty-two vehicles ranged about the Arc de Triomphe de l'Etoile on September 24 at nine o'clock in the morning, which began their run to Versailles on the same day towards noon, twenty-nine returned to Paris. The three which broke down were the only steam vehicles. Another triumph for the petroleum carriage.

This race was again won by a Panhard and Levassor

carriage, which covered the entire course in 67 hours 42 minutes and 58 seconds, equivalent to a mean velocity of 15·65 miles an hour. This carriage was followed closely by other vehicles of the same house. The greatest speed during a single stage was about eighteen miles an hour.

The Peugeot carriages also did good work. The firm Delahaye of Tours made its reputation on this occasion by one of its vehicles, which came in a good fourth.

But the most prominent event of this test was the extra-



'No. 6.' Winner of the Paris-Marseilles and back race, 1896, driven by M. Mayard

This was the first four-cylinder carriage built. (Eight h.-p. Panhard and Levassor.) Afterwards purchased by the Hon. C. S. Rolls.

ordinary power of resistance displayed by the new petroleum tricycles constructed by the firm Dion and Bouton. Contrary to all prognostications, these diminutive vehicles, the weight of which is hardly more than that of the man who mounts them, covered the immense course almost as fast as the carriages, in spite of horrible weather and a veritable equinoctial cyclone during the second and third days—from Thursday, the 24th, at midnight, to Friday, the 25th, at noon, the barometer fell about $1\frac{1}{8}$ inch.

As to the three steam vehicles, they could not accomplish the course. The Dion carriage, which had run the Paris-Bordeaux course, and which was driven by M. Bouton, stopped at Suresnes, even before the start was made, in consequence of a rupture in its large new pneumatic tyres, which M. Michelin had fitted to it without having studied and perfected them sufficiently.

The two other steam vehicles were almost identical brakes, especially constructed for this race, weighing about three tons when made ready for the trip, developing about eighteen horse-power when run in compound, and probably a little more than thirty when run by direct action from the large cylinder. Of these two powerful machines, one, in charge of M. de Dion himself, could not go further than Montereau, about eighty kilometres from Paris.[1] The other, of which my brother and I had taken charge, with a fireman and two machinists, took eighty-five hours to reach Lyons. During this long trip (we had only twelve hours' rest, from Friday midnight till Saturday noon), we spent forty-seven hours on repairs, on the open road —part of the time, and that the greater part of it (the night of Thursday to Friday, and of Saturday to Sunday), in a drenching rain. It goes without saying that, at the end of a dozen hours so lost, we made not the least pretence of catching up with our more fortunate competitors, but we wished to make a fight for the honour of the steam-principle by at least finishing the run, a purpose which we did not relinquish until the machine was entirely crippled at Lyons.

Almost every part of the mechanism was out of working order, and we had every break-down conceivable, except an absolute explosion of the boiler. We had even carried away a piece of the frame, which we replaced by means of an iron bar, forged by ourselves in a village.

I shall not attempt to give here complete details of this eventful journey, of which, however, I made most careful notes at the time. Exhaustive enumeration of all that happened to us

[1] An illustration of this car is given on p. 24.

would prove too lengthy. Suffice it to say, that we ran down a dog, overturned two carts (whose drivers, frightened at the sight of our enormous machine, turned to the left at the very last moment), upset a cow, and finally broke down a fence in trying to make a turn on soft and heavy soil. As for ourselves, in spite of our rubber hats, vests, and trousers, and the provisions of all kinds which we carried with us, we were in a condition which I prefer not to describe. My brother and I have been over some pretty rough ground in travelling—notably in India, in Japan, in Central Asia, and in the Sahara—but never were we so utterly tired out and so devoid of every similitude of humanity as when we reached Lyons.

In spite of all that, this carriage is a good vehicle. The accidents that happened to us were due to the fact that the machine had started without sufficient preparation and test. The proof of this is that, a few months later, in January 1897, the same carriage, in charge of my brother, after some modification and improvement, won in a brilliant manner the Marseilles-Nice-Turbie race, covering the 145 miles in 7 hours 45 minutes 9 seconds, a mean velocity of about eighteen miles an hour. This result is still more satisfactory if the exceptionally uneven and sinuous nature of the road is considered, as also the stops necessary to take in water and coke, and in fact that, without facing certain death, one dared not let the heavy vehicle coast on any of the heaviest down-grades.

It was on one of those down-grades that Charron, who was running a Panhard petroleum carriage, and who wanted to catch up with us at any cost, was upset at a turn. Charron and his machinist were thrown out, though they were not hurt at all, but the vehicle turned a complete somersault, and landed on its wheels—as was demonstrated in an undoubted way by the traces of gravel on the upper part of the carriage. It sustained no serious injury, except the destruction of the steering bar, which Charron repaired with a bit of wood. It returned to Fréjus without a stoppage of the motor.

The tests of Paris-Bordeaux and Paris-Marseilles had shown that automobile carriages can cover long distances on ordinary roads; Marseilles-Nice-Turbie went to show their practical value, by proving that they could get over the heaviest down-grades.

It was also on this last occasion that really considerable velocities were attained for the first time. Between Ollioules and Toulon we made five kilometres (3·1 miles) in less than five minutes; between Cannes and Nice, the speed officially registered for Michelin was about thirty-one miles an hour; ours was a little greater than that, since Michelin had left Cannes on his steam brake five minutes after us, and we were stopped for eight minutes on the outskirts of Nice by an over-heated axle, during which time he ran by us like an express train. The second prize was won by a Peugeot petroleum carriage; for, in the first part of the run, Michelin had lost considerable time by the rupturing of his pneumatic tyres, which he had not yet been able to bring to the highest degree of perfection.

In 1899, I wrote:—'This race was the only one ever won by a steam carriage, and it will probably be the last, in view of the incessant progress made to-day in the construction of petroleum motors, making it possible for them, other things being equal, to develop power superior to that of steam apparatus, as far as now known.

'Of course the petroleum motor has not the elasticity of a steam motor, but it has a peculiar steadiness and a wonderful power of endurance. It has but one weak point, its cylinder, and but one delicate structure, its carburetter, while the steam engine has numberless sources of injury in its boiler, its tubings, its pumps, its cylinder-heads, &c., which are simultaneously subjected to extreme pressures, due both to the steam and to violent jolts on rough roads. Besides, to make a one-horse-power hour with a petroleum motor requires about 0·750 kilo of oil, and since the invention of the radiator or surface-condenser, the same water can be used indefinitely

for cooling the cylinder. On the other hand, the steam motor requires for the horse-power hour about one kilo of fuel and ten kilos of water. The stops necessary to replenish are, therefore, much more frequent with the second of these systems than with the first.'

Since these events speed in races has constantly increased. In the Paris-Dieppe race in July 1897, a small Bollée carriage, a sort of tricycle with rear driving-wheels, made the run at a mean speed of about twenty-six miles an hour. Almost the same record was made by the first contestants taking part in the Paris-Trouville race, 105 miles, in August 1897. In the great race, Paris-Amsterdam-Paris, in July 1898, made in several stages, Charron, running a Panhard two-seated carriage, attained a mean velocity of 27·77 miles. Finally, in the Versailles-Bordeaux race of 1899, one stage without stop, the mean velocity attained by the winner, Charron, on the total run of 351 miles, was 33·30 miles. On certain quite lengthy stretches of the course, the mean speed passed thirty-eight, and at some points reached forty-five to fifty miles an hour. This carriage, from the establishment of Panhard and Levassor, weighs about a ton, and carries an equipoise motor of from twelve to fifteen horse-power.

Having traced the history as far as this interesting event, I must refer the reader for further information to the chapters dealing with the work of the automobile clubs and the records of races and trials.

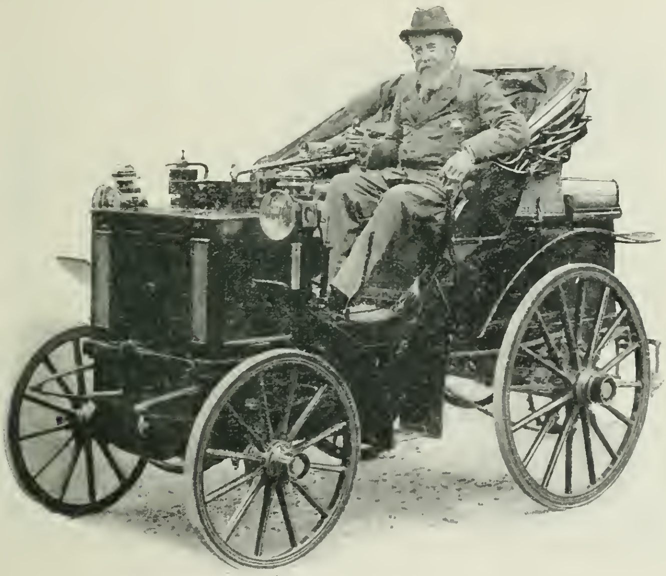
It would not be out of place for me to make a few remarks concerning those all-important factors which go to make the sport of automobilism a success.

Tyres.—It is impossible to refer to pneumatic tyres without recalling the firm of Michelin et Cie. With iron-tyred wheels it is impracticable to drive quickly without destroying, in a very short space of time, first the wheels and then the carriage.

With solid rubber tyres slightly more speed is obtainable, but the pneumatic is the only one with which, at present, it is possible

to attain high speeds with a measure of safety, and without causing the wheels to collapse, and damaging the transmission gear of the car, not to mention springs, frames and motor.

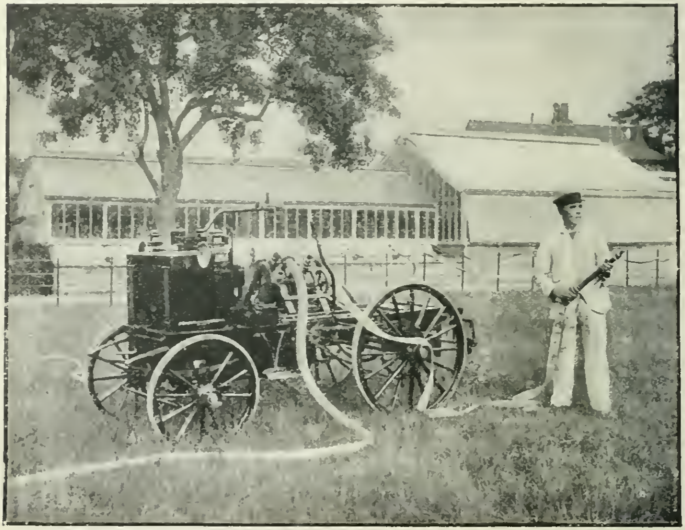
The part played by the pneumatic tyre at high speed is enormous: to quote Mr. Michelin's remark, 'it absorbs every obstacle'; it acts as a cushion and a spring, and reduces to minimum the very formidable objection of vibration.



The first Petrol Car introduced into England—the Hon. Evelyn Ellis's 4 h.-p. Panhard and Levassor Car

The revival of interest in mechanical road locomotion in the United Kingdom which followed the extraordinary performance of the carriages of 1895 in France was at first very gradual. The Hon. Evelyn Ellis introduced a four-horse-power car into England in the June of 1895, having used it in France for some time. Mr. J. A. Koosen on November 21, 1895, imported a Lutzmann car. Sir David Salomons

gave a demonstration of motor vehicles at Tunbridge Wells on October 15, 1895, at which members of Parliament and other prominent people to the number of fully ten thousand were present. In the meantime, a financier had purchased from Mr. F. R. Simms the rights for the United Kingdom in the Daimler patents. An exhibition of motor vehicles was held at the Imperial Institute, London, in 1896. At the same time companies having prodigious capitals were

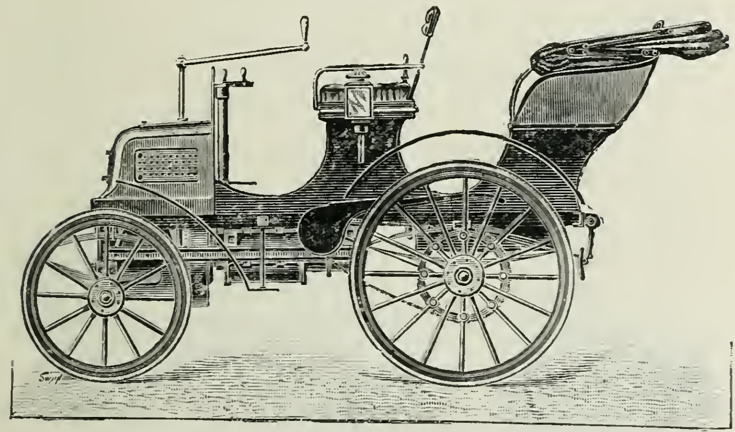


The Hon. Evelyn Ellis's original 4 h.-p. Panhard Car converted into a Fire-engine.

floated, and when, on November 14, 1896, motor vehicles were allowed to run on the roads, popular enthusiasm had been thoroughly aroused, and the start of what was virtually a race from London to Brighton on that day was witnessed by an enormous crowd.

It is only right that it should be recorded here that Mr. Ellis took up the motor movement from patriotic motives, and

supported some of the pioneer companies from his private purse to the tune of probably 20,000*l.* Sir David Salomons, although not financially interested in the industry, worked with great zeal and energy with a view to making the running of motor vehicles on the road permissible, and spent very many hours in advising the Government officials as to what the law should be. Mr. Shaw Lefevre, as President of the Local Government Board, was about to introduce a Bill when in 1895 the Government went out, with the result that the honour of bringing before Parliament the Light Locomotives Act fell to



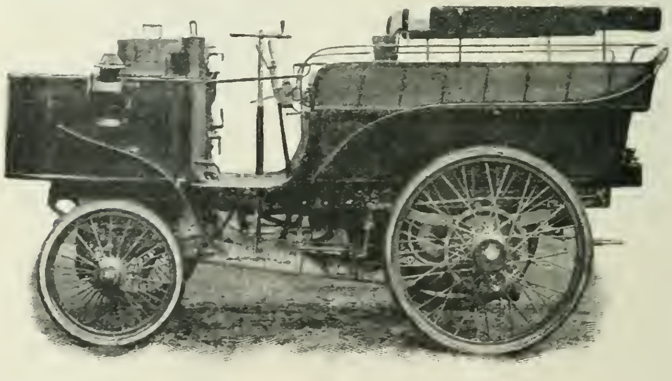
The first car built by the Daimler Company at Coventry

his successor, Mr. Henry Chaplin. Mr. Henry Sturmey, who had long been associated with the cycle press, was quick to recognise that the motor-car movement was to attain prodigious proportions, and on November 2, 1895, he produced the first number of a newspaper called 'The Autocar.' This he wrote and edited personally himself, unaided, for over a year, and continued the editorship of the paper until 1901. The 'Automotor and Horseless Vehicle Journal,' 'The Motor-Car Journal,' and other journals followed, but the honour of

being first in the field belongs to Mr. Sturmey, who also did much to illustrate in this country the practical utility of the automobile by making a journey from Land's End to John o' Groat's in October 1897.

Mr. T. R. B. Elliot (who, on December 27, 1898, was the first to drive a motor vehicle, a three-and-a-half horse-power Panhard, in Scotland, and drove 1,250 miles before the Act was passed), and the Hon. C. S. Rolls, who acquired a three-and-a-half horse-power Peugeot in December 1896, are amongst others who followed the lead given by Mr. Ellis and Sir David Salomons, by driving motor vehicles on the English roads before the law of 1896 came into operation.

The later history of automobilism in the United Kingdom and other countries will be found in the chapters on the work of the various Automobile Clubs and on Records.



The De Dion Steam Vehicle driven by the Marquis and the Count de Chasseloup-Laubat. (See Chapter I.)

CHAPTER II

THE UTILITY OF MOTOR VEHICLES

By the Hon. John Scott-Montagu, M.P.

It is now admitted by most people that the motor-car has passed the limits of mere experiment, and that it has become a practical vehicle. Motoring has already entered, and will in the future enter yet more largely, into our social life, though we may still be far from the time when the horse-drawn vehicle will be a rarity upon country roads and London has begun to save fifty thousand pounds a year now spent in road scavengering.

The utility of the motor is endless. At whatever distance you may live from your station in the country, the motor is bound to shorten the time occupied on the journey to and fro, and houses six miles from a railway become as accessible as houses three miles distant are to-day with horses. Whether you consider the motor from the town or country station point of view, the fact that there are no horses to get tired, and that the motor will run, providing it is efficiently handled, for any hour or all hours during the twenty-four, makes it inevitable that every country house of any dimensions, and nearly every private carriage-owner in London, will have a motor-car of some sort or kind in coming years. The difficulty at first is always the same in any new movement of this kind: the would-be buyer and future owner most probably knows nothing about the machine of which he is to be the possessor, and to get a trustworthy and capable driver and mechanician is even harder than the selection of the motor in the first instance.

I am inclined to think that for town work electricity and steam will be the main propulsive agents. The delightful

smoothness of either method, and the fact that, in the case of electricity, re-charging can be done so easily from any electric light system, are advantages not to be denied; and again, as broughams and landaus are largely used for night work, the same power that produces the motion will produce also a most brilliant light for your lamps, light your cigarette, and heat your foot-warmer. If it were not that there is yet no really satisfactory form of accumulator for traction work on the market, the electric motor-car would long ago have won a complete victory. At present an electric car may be classed as a charming but expensive vehicle, almost as costly as horseflesh. The expense of running an electric carriage, including stabling, electricity, tyres, batteries and insurance, is 180*l.* per annum. The steam car has been more favoured of late, but here again you have the danger which must necessarily come from a live flame in connection with petroleum or petroleum spirit—always called amongst motorists 'petrol'—and most of the steam vehicles now upon the market are extremely expensive to run, in fact nearly three times as expensive as an internal combustion engine producing the same power. I feel convinced that we must have a great improvement in steam vehicles before they will come into general use for light town work, and electricity ought certainly to hold the field, so far as one can see, for some years in this department.

Of course I am not discussing the question of heavier traction, the vehicles for which have been much more perfected than those for the lighter class of work. The Liverpool trials of 1901, and the military trials at Aldershot in December, proved that we can buy vehicles of undoubtedly great carrying power, and of 'extra-normal' capacity, able to tackle not only heavy roads and stiff hills, but even to make a fair show across country. There is probably nothing safer in the streets of London to-day than a well-driven electric or steam motor; there are no horses to fall down when the streets are slippery, and there is brake power available far in excess of any that can possibly be exercised by the horse with his four iron-shod feet

on a frequently treacherous surface. When your driver is careful and competent, has learnt the danger of skidding, and is content to take you round corners at a reasonable speed when the wood pavement or the asphalte is wet, you should be able to enjoy your newspaper or talk to your companion as you go

A Station Omnibus
(Eight h.-p. Panhard and Levassor)

along with as much serenity as if you were sitting in your favourite chair at home.

To turn for a moment to station work in the country. There is no doubt that the internal-combustion engine driven by 'petrol' is still the most practical of all the various types. Whether you have a Panhard or a Mors made in France, or a Daimler or a Napier made in England, on ninety-nine days out

of a hundred the vehicle will perform its work up to time, and, so far as I can speak from my own experience, you ought never to miss your train or your appointment if the car is efficiently superintended. One thinks a good deal in the country of going by train to one's station, say a hundred miles from London, in about two hours, and you naturally remark on the excellence of the railway service, but from there to your house, a distance of, perhaps, six miles, often takes you an hour in the country fly. The first part of your journey was completed at the rate of fifty miles an hour, the final average from door to door works out at a little over thirty. If the train service from your station is quickened to any centre which you are using by ten minutes in two hours, you think it is an extraordinary improvement and everybody praises the railway company; but with a motor you may save thirty minutes in every hour over the horse-drawn vehicle even in ordinary weather, and when it comes to snow and frost and slippery roads the saving might easily amount to far more.

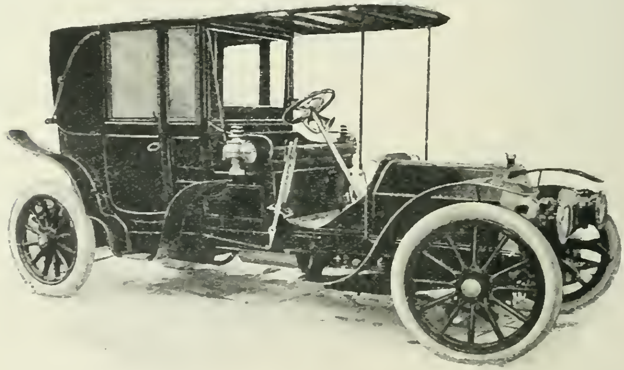
And when you are in your country house what an added joy to your daily life! Perhaps you are surrounded by a few near neighbours of whom you have seen almost too much, and beyond them a wider circle of friends from ten to twenty miles off, or even more, whom, without previous arrangement as to change of horses, you cannot conveniently reach. These now become quite accessible, and a shoot twenty miles from home can be undertaken, or you can lunch with your neighbour five-and-twenty miles off as easily in 1904 as in 1892 you could meet your friend living seven miles from your door. All this makes for an improvement of the social conditions of country life, a widening of its opportunities, a better knowledge of your county, and less boredom with your parish. But beware of the local Bench in the matter of speed. They may be sensible, and the policeman kind or blind, but all are not so. The poetry of pace generally leads to a payment before the prejudiced. Above all be a gentleman on the road as well as off it. It pays.

Then, again, as to the station work: your expected friend, we will imagine, misses the train; but there is no horse to catch cold waiting at the railway, followed by an intimation from your groom next morning that the horse cannot be used for three or four days owing to a bad chill. Altogether the motor-car must revolutionise our social life in the country, and let us hope before long will lead to the bettering of our cross-country roads. The horse, poor beast, has never been able to tell us what he endures from bad roads, and the pace of a horse-drawn vehicle has been too slow for even the springs to suffer much; but if you get into a motor-car going five-and-twenty miles an hour over a road which you have hitherto deemed good, the engine and car will very soon tell you the difference between what the road surveyor's work has been and what it ought to be.

For station work in the country I would rather recommend —and I am supposing myself writing for those who have now a stable of some half a dozen horses—a covered as well as an open motor, or perhaps a motor which can have a top fitted on to it when the weather is bad. Ladies do not like arriving at tea-time with their fringes out of curl, or the feathers in their hats drooping or facing the wrong way; but always remember that the driver should be quite free, and that nothing is more dangerous on a misty day, and especially at night, than a glass frame on which the rain will fall and eventually almost obscure the road from his gaze. The man who drives the motor must always have the best possible view of the road, just as on the footplate of a locomotive every driver knows that in times of mist or rain the difficulty of seeing through the windows of the cab is immensely increased, and careful drivers prefer to have their heads round the edge.

For hunting work you must bear in mind the susceptibilities of the district. I am glad here to be able to put on record—for it will seem curious a few years hence—that a Master of one of the Midland packs has asked the members of his hunt to avoid using motor-cars for the purpose of coming to meets,

and generally to discourage their use, on the ground that the farmer will be deprived of part of his income owing to the diminution of the demand for forage, by which hunting will be prejudiced. It is notable that similar arguments were used in the years 1838 to 1845 during the construction of the early railways; and yet the horse is with us still. It would be rash to say that the farmer will suffer by the introduction of these new vehicles, for if he loses in the amount of corn or hay sold for a few covert hacks or carriage horses, he may gain by the fact that many more people will hunt if they have facilities for



28 h.-p. Mercédès Brougham, 4 seats
Extreme length, 12 ft. 4 in.

attending distant meets, and that the farm produce itself will probably be conveyed at a much cheaper rate than is possible now either by horse-haulage or rail. There are notable Masters in the Shires who already employ motor-cars to take them to their more distant meets, and as I write I have the names of several gentlemen in my head who would be recognised throughout the hunting world to be as good sportsmen and as straight riders as any in England. The use of a motor for every kind of social appointment is bound to increase, and I am afraid some of the Midland farmers are

more like Mrs. Partington than they could be persuaded to believe.

To come to other country pursuits, both for shooting and fishing, rapidity of transport will do wonders. You have often, for instance, in Scotland a lodge near your forest where the stalking is good, and possibly a few brown trout in the burn below. But ten miles away, perhaps over a good road, there is an excellent sea trout or salmon river which is only accessible after a good deal of organisation, and if the road is hilly, the expenditure of an hour or an hour and a half of time. The new mode of locomotion will make river, loch, and forest accessible from the same centre. Moreover, many places in Scotland which are beyond ordinary driving distance from the station, thirty or forty miles away, will not be so cut off from the outer world as at present, and your 'Times' will be only one day instead of three days late. On precipitous roads, if your horse backs you have frequently a very nasty moment or two; but motor-cars do not shy, neither do they back unless you wish them to do so. Proverbially, once more, there is nothing so uncertain as fishing. You may have a good day and wish to stay till the very latest moment, or the water may be out of order, the fish not on the rise, and you may find it desirable to alter your whole day's plans. If you have driven a long distance the horses must have rest, and very often have been put up at a farm some way from the water, whereas the motor is left on the road at the spot nearest the stream, and should you decide in favour of some other kind of sport, or a return home, you can change the rod for the gun, or rejoin your wife, go back to your garden, or possibly to 'bridge' or 'ping-pong.'

For ordinary partridge- and pheasant-shooting in England motors have already taken their place as practical vehicles; and I may here remark that it is all-important that we should not lead motor manufacturers to imagine their cars are only to be used in the summer-time, when the roads are good and when you can arrive at the end of your journey with your paint showing in all its glory. For country work the car ought to be

able to run all the year round, and whether it is smothered in mud, or almost obliterated by snow, to be of practical use you should not spare the car in the winter-time. You will find out more weak points and need for alterations in one day in December than in a dozen days in June. Have, say, a six- or a twelve-horse-power car for the loaders, a good roomy wagonette with a low gear and plenty of floor space, let them start a quarter of an hour earlier than you, and follow them in your flyer, on a twelve- or twenty-horse-power machine with your guests. Many a last beat of a good shoot has been spoilt because one of the party was not called in time, or was eating his breakfast when the party ought to have been starting. You can now allow a wider margin. The beats which, if you left home at ten, were finished with difficulty, can by the aid of a car be so accelerated that at the end of the day you will probably have a quarter of an hour in hand.

And there are other forms of shooting which can now be enjoyed and which formerly were impossible. I will suppose that your shoot has many natural advantages, and that there are duck pits and snipe marshes at certain places on the property. With two good motor-cars such as I have described you can take four or five guns and loaders; you can visit all of these places in the day, and make a total of wildfowl and snipe which the Game Book will tell constitutes a record. I have myself worked on this system for three or four years past with great success, and a hundred wildfowl a day shot out of small lakes and pools, added to a few snipe and 'oddments,' will make your day one to which you need not disdain to ask your best shots and your cheeriest friends. Twenty to five-and-twenty miles like this can easily be covered by your motor, and you will hardly realise the distance you have been over by the time you return home. To ask any pair of horses, or even a four-in-hand brake, to cover the same mileage, with the roads bad as they generally are in the winter, muddy and soft, with, probably, five guns in the one brake and five loaders in the other, and perhaps

'GUNS' ARRIVING BY MOTOR

an extra keeper and a dog or two thrown in, is such a serious business that you will find four pairs of horses can barely do the work, and next day they will very likely be unworkable.

Let me give one word of advice as to motoring to your shoot. Always wear spectacles, and have a pair or two for your guests who sit on the front seat with you. The keen air of a frosty morning, or driving rain at top speed, will not increase the accuracy of your aim, let alone the chance in the early autumn of a gnat in your eye, than which nothing can sometimes be more painful, or, later on in the year, a speck of gravel which may cut you like a knife.

As to wildfowling, you can go to your punt more rapidly in the morning, and an extra ten minutes in bed will be welcomed by anyone who has had experience of early punting. You can also, when the opportunity presents itself, shoot your Golden Plover from the motor-car without any chance of your horse suddenly bolting at the discharge, and wood-pigeons and cock partridges later in the season can be brought down from the road after a little practice with the greatest ease, without rising from your seat. Rabbits and hares at night will run sometimes for a quarter of a mile before your acetylene lamps, and you can pick them off in the same way with your gun ; oftentimes with your car you will unintentionally run over panicked rabbits or hares who dash frantically under your wheel. It is always worth while stopping to see whether you have secured your quarry ; and although the mode of killing may result in the hare being more fit for soup than for roast, at times you will be lucky, as I have been, and a head that its mother would not know is the only damage done.

For household purposes, if you live at a distance from your country town, you will find a motor-car of great use for parcels, for sending away your game, and for bringing your supplies ; and let me also mention that your servants, should you care to give them a day's outing in the summer, will enjoy a motor-car drive and a picnic in the woods with a zest which they never knew in the days of the horse-drawn vehicle.

Now I come to the last section of my chapter, the use of motors for farming and estate work. And here one must go from the point of view of convenience to that of economic and practical use Whether the rates charged by railways to-day are justifiable, having regard to the capital of those railways, or whether they are excessive with regard to the low rates charged on competitive foreign produce, the cheaper and swifter locomotion becomes, the better must it be for the British farmer; and incidentally I must strongly advocate some form of co-operation where it is possible. At Tunbridge Wells a system has been started, whereby the farmers of the district, tired—and no wonder—of the vagaries of the South-Eastern and Chatham, have organised a motor service to take their goods direct to Covent Garden and other markets in London. And just think for one moment of the advantages gained. There is no handling from the farmer's cart into the truck, with all its attendant risks to perishable articles; and there is no handling at the London terminus, with the risk of crushing in the carrier's or railway company's van. The motor-car takes the fruit, or whatever produce is desired, to the market, and thus there are two handlings as against four handlings. Not only this, but the vehicle can return from London, or the town you may chance to be near, with nitrate of potash, bone meal, linseed cake, or whatever you are buying from the outside for consumption or distribution on your farm; and as every merchant in the world will tell you, the secret of paying freight is that the vehicle or ship should be full both ways. What an advantage it would be to London, and what a saving would result, if you could have fresh eggs gathered from five to seven in the morning and delivered to you at your door at eight or nine o'clock for breakfast! Nowadays only milk and cat's-meat are taken to your house, both moderately fresh, but the London egg is neither moderate in price nor is it generally new-laid. The cry of 'cat's m-e-e-a-a-at!' may bring but few householders of the better class to the door, but we may live to hear a long-drawn-out cry of 'e-g-g-s!' which will tempt every housekeeper

with her pennies in her hand to get the early morning egg fresh for breakfast. There are also the fresh fruit and vegetables which in future days, perhaps, a fatherly or grandmotherly municipality will distribute in their cars to you.

The use of motors for market and farm work is yet in its infancy, but I can see no reason why the distribution of perishable goods from a moving centre should not be one of the improvements of coming years. Take, again, the instance of thousands of acres of land in this country which are from six to ten miles from a railway station, with perhaps a rail journey of another ten to the county or market town. By a little arrangement and organisation tenants farming this land could, three days a week, send their produce to market, and, moreover, if it is not sold at satisfactory prices, the articles could come back at no greater expense than that which it would cost to run the car, which in any case would have to return, and is not likely always to have a full load. The grip of the provincial salesman on the farmer lies in the fact that if the latter takes his produce to market he must sell it before the end of the day, for to bring it back by rail, and to have a cart to meet it at the other end, would be financially suicidal. The farmer, therefore, is always at a disadvantage, and the middleman takes a bigger proportion out of the agriculturist than perhaps in any other trade.

For estate work, where there is a staff of builders or carpenters, a motor-car will prove a great saving. When once the capital outlay is faced, scattered cottages and farmhouses can be more easily and economically examined and attended to, and perhaps repaired even in the hours between sunrise and sunset. If your carpenter or bricklayer has to walk five miles to his work, in the winter, he will certainly not begin much before nine o'clock, and he will walk back in your time and not in his. Small blame to the man for that. The absolutely efficient hours of labour are thus reduced by nearly thirty-three per cent., and the work will cost you correspondingly more. In the case of the breaking down of a bridge,

or the falling in of a roof, or the choking of a drain, you can concentrate, by means of a motor that will carry ten to twelve persons in it, a large force and meet the emergency, and perhaps save the situation before any very great damage is done. I should recommend for estate work a good rough wagonette which can take materials as well as persons, with plenty of engine power, say, not less than twelve-horse, and a low gear which will make a load of bricks or half a dozen bags of cement a possible freight. And, above all, have electric ignition, and only use tube ignition, if you have it, in cases of emergency or breakdown in your electrical arrangements. Otherwise a flare-up and a charred car is a daily possibility.

It is necessary that an agent on a large estate should be as independent of time and distance as possible. Give him a light motor-car, and let him get one of his stable-boys or farm-hands properly instructed in its care and use at one of the centres of the automobile industry. His work will be more efficient and his control of his staff more complete.

Although I may be accused of prejudice, I personally favour an English-built car for these purposes. The work in them is, I believe, better, the material is certainly stronger, and as strength and durability are more essential for practical work than paint and artistic lines, I should recommend my readers to go to the well-known English firms for their vehicles.

For golfing, yachting, and in fact for every pursuit where you have to go from home to begin your day's amusement, the saving of time will grow upon you, and give you more leisure moments and more hours of amusement. The War Office, who have of late become more practical in these matters, are genuinely taking efficient steps to perfect mechanical traction for the army. The one department—the Post Office—which has especially to cover long distances, and to whom the saving of time ought to be, but apparently is not, of the utmost importance, appears stolidly indifferent. Just as for years after the introduction of railways the Post Office fought shy of the use of

them for mails, there are still provincial towns near London to which a seedy pair of horses and a broken-down-looking driver convey His Majesty's mail every day or night. We have no chance at present of seeing a saving of time in the matter of the rural postmen or the provincial mail-cart. Why should there not, for instance, be a late motor-mail service from London, leaving about two A.M. after all the main-line railway services have ceased, to convey letters, perhaps posted with a late-fee stamp, up to midnight for the country, and deliverable in towns within a hundred miles of London by the first post next morning? I am confident that were an experiment of this kind started the number of letters so posted would very soon make the demand for motor-cars a very large one on behalf of the Post Office, and the convenience to the public would be undoubted. From eight o'clock in the evening until eight o'clock the next morning you cannot telegraph to most country towns, and after eight o'clock, unless you send to the mail train at the terminus, correspondence by letter is impossible. There must be thousands of people every night in London, and in every provincial centre, who would gladly pay an extra penny, or even twopence, if they knew that by so doing a letter would be delivered next morning by the ordinary first post. A motor-car also enables one to send a written message to a telephone station night or day.

That the motor-car has come to stay is a commonplace, but few can foresee what a change it will make in our economic, political, and social life. I believe that the revolution worked by railways is a small thing compared with the revolution to be produced by the motor-car.

CHAPTER III

THE CHOICE OF A MOTOR

By Alfred C. Harmsworth

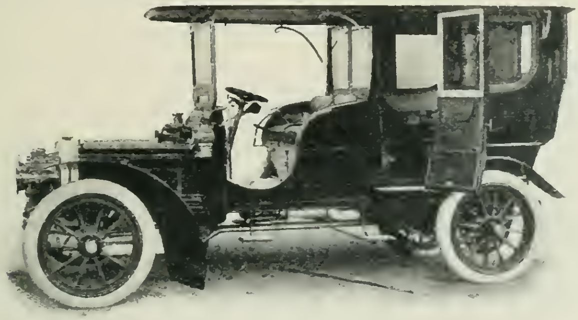
Few undertakings require more care and caution than the choice of a motor-car. Of the many hundreds of types and varieties now in existence, many are of no practical use, some are extremely complicated, not a few dangerous, and many more or less faulty in construction. The difficulty of the choice is increased by the fact that almost every enthusiast recommends the particular kind of carriage he himself possesses, and in addition every manufacturer claims, and possibly believes, that his is the only possible automobile.

My own experience, though not nearly so extensive as that of such veterans as Mr. Rolls and many others, is, I venture to believe, as varied as that of most chauffeurs, and I think I can claim to be free from prejudice. I am running at present three cars of German construction, two of English, and two of French.

If one intends to own a single motor-car only, and desires occasionally to travel for long journeys, there can in my judgment be no doubt that a petrol engine, with a Daimler or some similar type of motor, is the wisest purchase. The point is a contentious one ; but I selected this type of engine as the best for use seven years ago, and since then time has brought almost every motor manufacturer to my side. One after another the Continental makers have copied the shape and design of the German Daimler engines. Among the many advantages of this type of engine is that it is easy to get at, is

simple in construction, understood by more mechanics than any other engine except perhaps the De Dion in France, and so lasting in quality that Mr. Evelyn Ellis, who brought the first four-horse motor to this country in 1894, still has it, though it now does duty as a fire-engine.[1]

Quite the most perfect cars are my two electric carriages, one a Columbia phæton, and the other a small brougham supplied by the City and Suburban Electric Carriage Company; but—and it is a big but—they are limited to a range of fifty miles, and though there are constant improvements in batteries, and electric charging stations are springing up all over the country,



18 h.-p. English Daimler[2]
Extreme length, 14 ft. 6 in.

I can only at present recommend them for a twenty-mile radius round a house in town or country—for that work they are not to be excelled. Only those who have suffered the experience of seeing a valuable pair of horses losing their step and style can realise what a help to a stable it is to have one electric carriage on the premises. For shopping, theatre and station work, an electric carriage is an inestimable boon.

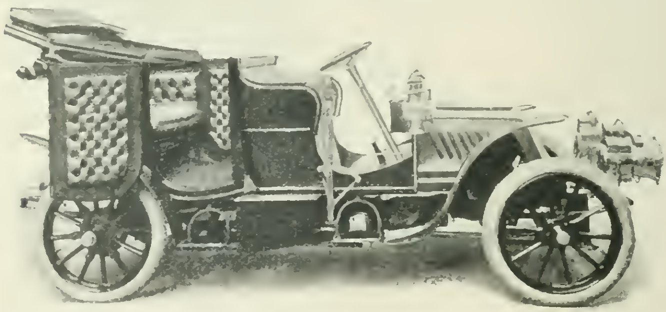
In considering the purchase of a motor-car I will assume that the reader desires only one, and that it will be required to

[1] See the illustration in Chapter I.

[2] The illustrations in this chapter are given simply to represent some of the types of cars now in use.

do all kinds of work. This involves, then, that such a carriage must be either closed or else so made that a top can be fixed to it. Altogether insufficient attention has been paid to the question of covered carriages in England, but not so in France. One of the most noticeable features of the Exhibition of December 1903 was a recognition of the fact that a motor is not a mere fine-weather phæton, but a carriage to be used at all seasons.

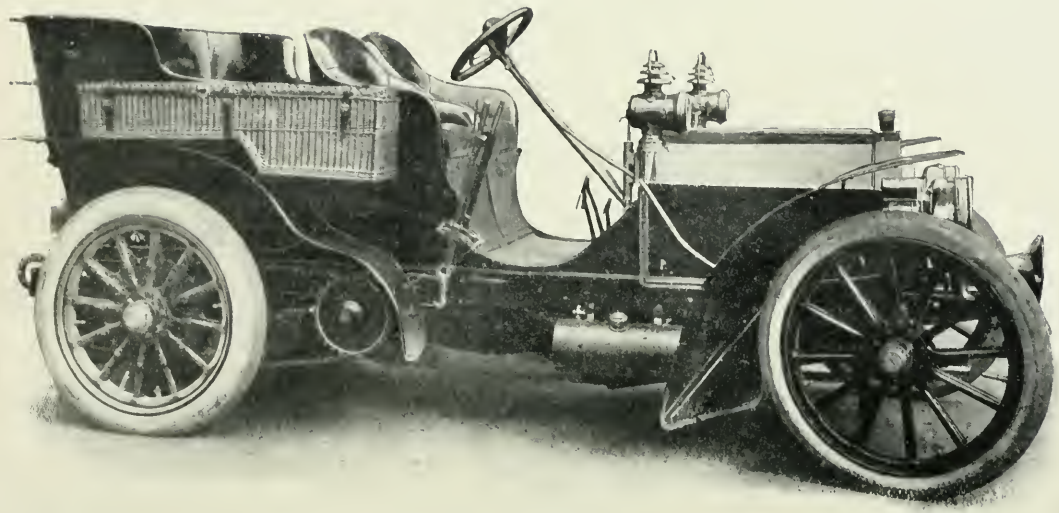
The day of the tonneau carriage with its back entrance, of goggles, impossible hats and coats, and the other extraordinary garments which were the result of the speed mania, is passing away, and those who have recovered from the malady are on the look out for a petrol carriage which shall as nearly as



15-19 h.-p. Ariel Coupé Landaulet

Extreme length, 12 ft.

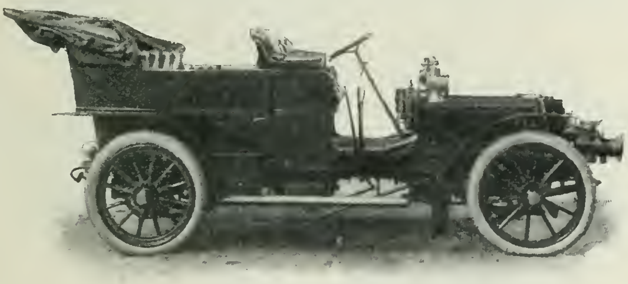
possible approximate to the electric carriage as regards the noiselessness and the absence of vibration and smell which form its chief attractions, but which shall not be limited in its distance capacity as the electric vehicle is. The high speed sporting carriage has no longer any charm for many motorists. They desire a comfortable modest-looking vehicle, fitted with an engine of sufficient power to maintain a speed of twenty miles an hour, of low compression and amply silenced, and with a body which may be entered from the side and may be closed or open at the pleasure of the owner. Many makers both on the Continent and at home have turned their attention to the



MR. LIONEL DE ROTHSCHILD'S 35-40 H.-P. MERCEDES (1894)

manufacture of such a carriage, and at least one of the illustrations to this chapter show that as regards elegance of design a really pretty petrol brougham has been made in England, although I cannot say how far it fulfils the requirements of trustworthiness, silence, and absence of vibration and smell.

Assuming, again, that the reader has decided on a petrol car, the matter becomes a question of cost. We have been told for a number of years that the motor-car would soon be very much cheaper, but so far this is only partially true. The day of fancy prices caused by the demand of very rich people for something of which the output is very limited is almost gone, but it is difficult to suppose that one will ever be able to buy a well-built carriage, drawn by a complicated and beautifully



28 h.-p. Gladiator
Extreme length, 12 ft. 2 in.

constructed piece of machinery, for anything approaching the price of a mere brougham or victoria. Yet that is what many people expected, forgetful of the fact that a motor-car is a horse and carriage in one, that its stable bill is of the smallest, that it ceases to consume oil or spirit immediately it is at rest, and that although its tyre bill, and accounts for occasional repairs, may be high, it is not subject to half the troubles that worry the owner of even the best-conducted horse stables.

LIGHT CARRIAGES AND VOITURETTES

The names and descriptions of these are legion. The owners of large cars are sometimes apt to despise the little

20 h.-p. Talbot
Extreme length, 12 ft. 6 in.

cars, as the driver of the four-in-hand disregards the pony-chaise. Some of these little cars are somewhat trying to people

12 h.-p. De Dion Phæton
Extreme length, 12 ft. 6 in.

with sensitive nerves. They have single-cylindered motors which run at high speeds, and their clatter is intense. But

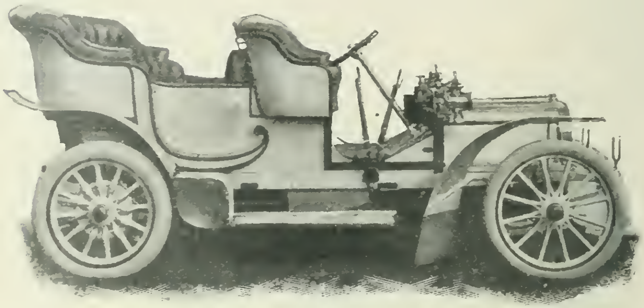
they are frequently swift and easy to manage. The very light voiturette is giving way to the light car. Perhaps the most perfect model of the newer type is the 14 horse-power Renault. It may be said to be the direct outcome of racing. Its top speed is fifty miles an hour, and it will average twenty-five to thirty miles an hour in almost any country. But far cheaper vehicles can be purchased which are sound and ser-

14 h.-p. Renault

Extreme length, 12 ft. 2 in.

viceable carriages, but the beginner should on no account be induced to purchase any car that has not proved its trustworthiness in the official trials of 1,000 miles which are held annually. Some small cycle repairers now call themselves motor manufacturers and are selling cheap cars which are absolute rubbish. On the other hand the big manufacturers are selling excellent cars at comparatively low prices. I cannot do better than refer readers to the results of the Club trials, some of which will be found in the chapter on Records, and,

indeed, to the results of the Club trials generally, which may be obtained by the public by writing to the Automobile Club, London.



Léon Bollée

Extreme length, 13 ft. 3 in.

Light carriages known as *voiturettes* can be purchased for 120*l.* upwards, and many of them are good of their kind.

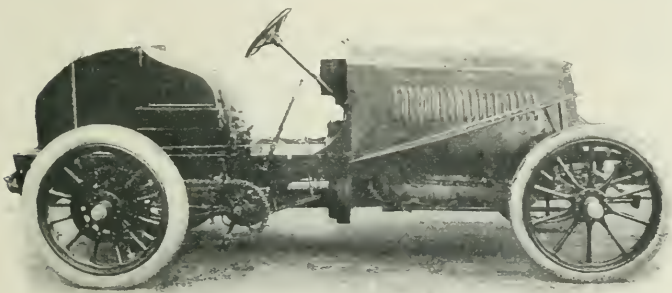
12 h.-p. New Orleans

Extreme length, 11 ft. 3 in.

Assuming that the purchaser has 500*l.* to lay out, for that sum he can get a ten to fifteen horse-power carriage with the Daimler type of engine, capable of carrying four people in-

cluding the driver, with a covered top for wet weather. Nay, if he be satisfied with a light and frail open carriage he could obtain one of much higher horse-power, and a speed up to between thirty and forty miles an hour; but this is a mere racing machine for those who desire to travel speedily without any protection against the weather.

If the purchaser intend to run his car on economical lines I still, as in 1901, advise mixed tyres, that is, solid tyres on the back wheels and pneumatic on the front. Although the speed is considerably reduced, a great source of expenditure is avoided. I am inclined to think that the pneumatic tyre craze has been



Panhard and Levassor Racing Car, on which the Chevalier Réné de Knyff finished second in the Gordon-Bennett race of 1903

altogether overdone by motor-car owners. At the present time I am using solid tyres entirely on one car, and on another mixed tyres, on yet another pneumatic tyres shod with metal, excellent for town use, and on a large and fast car, pneumatic tyres all through. The pneumatic tyres are undoubtedly the most comfortable of all, they are beyond question more speedy, but they are very costly. They are also very liable to puncture in hot weather, more prone to cause side-slip, and in several ways a luxury that has to be paid for. I advance these points to prevent the purchaser from definitely committing himself to pneumatic tyres because other people use them. I admit that the pneumatic tyre is a beautiful piece of con-

structive work ; still for some time past I have been gradually increasing the proportion of solid tyres in my stable.

In referring to horse-power, though I do not wish to encroach on the mechanical portion of this book, I would point out that to the lay mind the term is very misleading. It was thus that the earlier motor-cars were greatly underpowered. The average man imagined that a one-horse engine was equal to one horse, that therefore a six-horse was equal to six horses, and that a carriage propelled by six horses was good enough for anyone. The term horse-power is open to much misconstruction, and it is very loosely used by manufacturers in their advertisements.

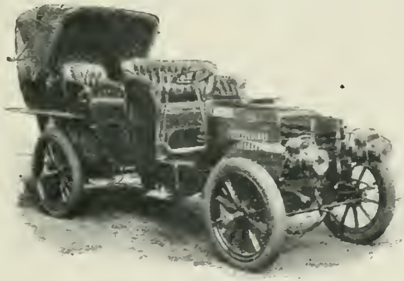
As to advertisements generally, I advise considerable caution in accepting them as gospel. No manufacturer would decry his wares, and the statements of the leading firms of makers may, as a rule, be received ; nevertheless, any person who has carefully considered the pages of advertisements in the motor-car papers will long ago have come to the conclusion that for ways that are dark the motor-car agent is, in some cases, a long way in advance of the horse-dealer.

A good motor carriage, of course, requires constant care and attention and skill. I was talking recently to the owner of several very good cars on which he had spent some thousands of pounds. They had been turned over to the care of a coachman, with the result that, though the poor fellow did his best, the vehicles began to be regarded as a mere nuisance. One would not dream of putting a coachman in charge of a printing machine, a steam launch, or a cathedral organ ; yet each of these exquisite pieces of mechanism is as little associated with a stable and a coachman as a motor-car. Coachmen can be taught to *drive* motor-cars, but there is a great difference between mere driving and a mechanical comprehension of the machinery. In the case of the electric carriage, a shrewd coachman or groom can easily be trained to take complete charge.

A good many people interested in motor-car matters are

prone to the assumption that the motor-car question is a very simple one. To the horror of a good many of my enthusiastic friends I have always been bold enough to make two statements, first, that in unskilled hands the motor-car is very dangerous to its owner, its passengers, and others ; and secondly, that the motor-car is as complicated as the horse. In skilled hands undoubtedly the motor-car has no compeer ; it is a safer means of travel even than the railway. The chief danger is 'side-slip,' and in an article which I had the pleasure of contributing to the 'Badminton Magazine' I made the following remarks :

Personally I regard a twelve-horse power automobile as almost as dangerous as a four-in-hand. I object to driving behind a



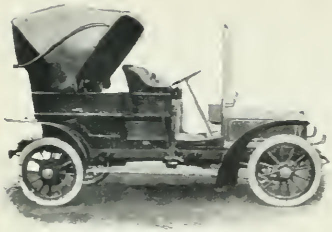
24–32 h.-p. six-seated Panhard et Levassor
Extreme length, 14 ft. 0 in.

spirited team unless in proper hands. I refuse to drive in a motor-car unless I know the abilities of the driver. The automobile is free from the dangers that follow shying, bolting, rearing and running away, but it has an equally dangerous enemy in side-slip. Nearly every motor accident one reads of is an exaggerated account of a side-slip ; and yet nearly every side-slip is avoidable. Side-slip amounts to this, that one cannot rapidly apply the brakes on greasy wood, asphalte, oolite, macadam, or stone blocks. The result of such application is invariably unpleasant, sometimes dangerous. There are patent tyres which minimise the danger, but let every person who purchases a motor-car recognise that it *is* a danger, and one that cannot be avoided by the most skilful driver unless he proceeds slowly on dangerous road material.

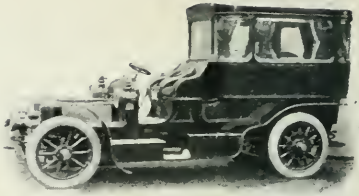
The causes of side-slip are discussed by other writers in this book, but one cannot be too careful in touring, in mountain country especially, to watch the road material as one goes along, and to be ready at any time for very careful driving. There are certain conditions of some kinds of roads when it is almost impossible to drive a motor-car with safety even with one or other of the numerous forms of non-slipping tyres.

An extremely bad piece of road on a very wet day, for example, is that into Cannes. Coming into Cannes from Marseilles there is a slight declivity just outside the Hôtel Beausite. I have driven up and down that piece of road many scores of times, but on one bad day I found it practically impossible to steer properly. Some of those roads in Kent and other parts of England in which the chalk surface has become exposed require careful negotiation. But the most dangerous road of all is during a partial thaw after a heavy frost. I can offer no suggestion for driving under these conditions. In the course of a winter tour during which one goes in a few minutes from green plains into half-frozen mountain roads, it is difficult to know how to continue one's journey. Mr. Mayhew, one of the best drivers in England, once described in the gazette of the Automobile Club an experience in which he came rapidly backwards down a hill during a wintry run. He was unable to exercise any control over his car. Fortunately, however, these incidents very rarely occur. I have made a three-thousand-mile journey in France without any occurrence of the kind; on the other hand, I have had a week of travelling on snowy and wet roads on which one had to fight against side-slip all day long.

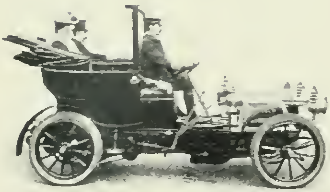
It would be grossly unfair to many excellent makers if I attempted only to support the Daimler type of engine. Other good ones are in existence, and the next few years will doubtless see further developments. The danger to be faced by beginners is that they should be over-persuaded by enthusiastic inventors and makers to purchase a machine the description of which reads excellently on paper, which



14 H.-P. DECAUVILLE

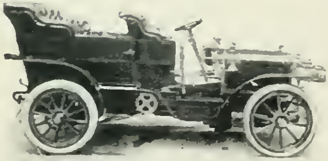


MOTOR MANUFACTURING CO.'S
SALOON CAR



15 H.-P. NAPIER LANDAULET

1904 MARTINI CARRIAGE



24 H.-P. NAPIER
With Side Entrance Body

18 H.-P. HOTCHKISS (1904)
With Sliding Front Seat to admit to Back Seat

makes a very good trial trip, but which is of no real practical use. For this reason I would always urge that the actual purchase of a motor-car should be deferred until the last possible moment, until by experience and by enquiry real knowledge has been gained. For this purpose membership of the Automobile Club of Great Britain is a practical economy. Many automobilists have saved their entrance fee and subscription again and again by the opportunities offered by the Club of gleaning information. Other practical advantages of membership are pointed out elsewhere in this work, but I consider that in the present chrysalis state of the movement the opportunity of receiving unbiassed information such as is ungrudgingly accorded by one member of the Club to another is of the greatest possible assistance. Among its enormous

24 h.-p. Wolseley
Extreme length, 13 ft. 0 in.

membership will be found owners of almost every known make.

To a man of leisure who is also of a mechanical turn of mind the management of a motor-car is doubtless a pleasure, but a very considerable amount of time is required for keeping the engine in order.

For some years I have made long Continental journeys in motor-cars, and have hitherto been exceptionally fortunate in

avoiding breakdowns of any kind. My friends have been surprised at the punctuality with which we start in the morning and arrive at our destination, some two hundred miles off, in the evening. They are unaware that my engineers have spent at least an hour on each car before starting in the morning. Such care may not be necessary, but it is certainly wise.

One need not run to the other extreme of constantly tinkering with the machinery, a very common fault with amateurs. The desire to 'take the thing to pieces and put it

30 h.-p. Napier (six cylinders)
Extreme length, 14 ft. 0 in.

together again,' and say afterwards that one has done so, is very great.

The numerous difficulties of cars, the little things that happen, are ably dealt with in the other portions of this work, which should be carefully read by everyone before purchasing a motor. My own experience is that a long run on a wet day in hilly country will, as a rule, find out what is wrong.

One must not on the other hand be too critical. In showing off a horse or a motor-car it not seldom, unfortunately, happens that neither is seen at its best. I remember in the summer of 1901 going for five months without a puncture of

any kind in a certain twelve-horse car. I was punished for a little bragging by the occurrence of no fewer than three punctures one afternoon, while conveying a friend, to whom I had been congratulating myself, on a comparatively short journey.

Hardly any class of motor-car is so generally useful for country-house work as an omnibus. Wishing for something more speedy than an eight-horse Panhard, I purchased a twelve, and converted my old friend into an omnibus, which has proved eminently satisfactory for station work. Carrying four inside and one beside the driver, with ample room for luggage, it is a great relief to a horse stable in very hot or very wintry weather. It is geared down to twelve miles an hour, and pneumatic tyres have given way to solid. Were I ordering a new omnibus, I should not do so without at least a twelve-horse engine and seating capacity for ten, with luggage; and for heavy work in hilly country an even higher horse-power would be very desirable. My carriage was converted by an ordinary firm of London carriage-builders, who made no pretence of building lightly, and who were not aware that long journeys at twelve miles an hour will in time cause the windows to shake. These, however, are the only defects we have discovered in the converted carriage, which has frequently made journeys of a hundred miles a day with passengers and luggage. The form, of course, is not suited for long distances, as sitting sideways all day becomes very fatiguing.

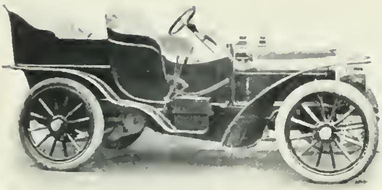
There are now so many forms of covered vehicles that it is difficult to recommend one particular shape in preference to another. One description, however, possesses a danger with which I should like to deal. I refer to those carriages which are entered by raising the front seat, which have no other means of entrance or exit, and in which the passengers are in a trap; but it is difficult at present with the ordinary short frame Daimler type of chassis to have a satisfactory carriage which one can enter from the sides. Length of frame is, however, becoming quite general.

As to touring, if one has a party it is pleasant to take two cars, one faster than the other. The fast one can be sent on ahead so that dinner and rooms for the night may be ordered. It is never wise on such a journey to attempt too great distances in the course of a day; personally, I am quite satisfied with a minimum of 120 miles, and in the short days of winter less is enough. To try a greater distance means very early rising or proceeding in the dusk on strange roads—always an unwise thing to do. Averaging twenty miles an hour and allowing two hours for meals, exercise and sight-seeing, one finds that eight hours of a winter's day are gone when one's 120 miles are finished. In the summer, when touring is of course pleasanter, one can travel two hundred miles a day with the greatest ease and without discomfort.

A very useful form of motor-car is a beaters' or luggage-car, that is to say, a long wagonette. Mr. John Scott-Montagu has pointed out, in his interesting contribution to this book, the great utility of a car for conveying beaters or loaders. I would remark that such a carriage can also be used for conveying heavy goods and guests' luggage. It would not be difficult to get one made with an omnibus top for use if necessary.

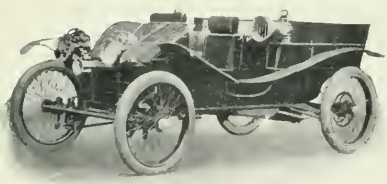
There seems to be an impression that motor-cars should all be of a certain shape. The Tonneau body is at present the most popular. As a matter of fact one can get almost any shape one wishes, but experience has proved that forms of carriage which are suitable for horse-driven vehicles are not always equally suited to motor-cars. With certain kinds of engines, too, it is difficult to adopt any other form of car than the Tonneau, or for the wet weather the Limousine. Some kinds of carriage bodies are obviously heavier than others, and, therefore, take away from speed, but I regard the suppression of mere open carriages for use in warm weather only as a matter of the very near future.

Though I am the possessor of some of the most powerful motor-cars in England, I am not at all an admirer of them for ordinary use. Even with what is known as the 'throttle' system of governor, by which one can reduce the speed as much as one wishes, I consider that these heavy and powerful

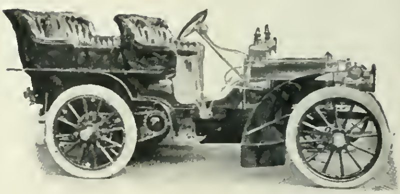


18 H.-P. SIDDELEY
Extreme length, 11 ft. 10 in.

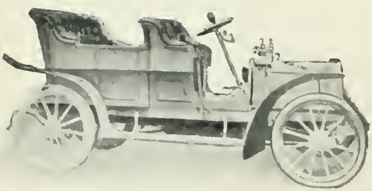
DURYEA
Extreme length, 12 ft.
From the *Automotor Journal*



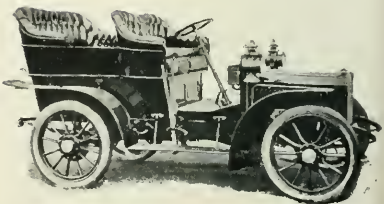
LANCHESTER
Extreme length, 12 ft.



24 H.-P. F.I.A.T.
Extreme length, 11 ft. 8 in.



GEORGES RICHARD BRAZIER
Extreme length, 12 ft. 10 in.



12 H.-P. DECAUVILLE
Extreme length, 10 ft. 4 in.

road engines are a mere passing freak of the hour. So far as this country is concerned, there are very few roads on which they can, so to speak, be let loose. On the long, straight roads of France, it is pleasant to indulge in an eighty miles an hour spin now and then, but when one considers the rapidity with which these monsters consume tyres, the fact that they are not at all suited for the conveyance of ladies, and are most uncomfortable on wet, windy, or dusty days, I am inclined to think that a few years will see their disappearance.

Quite the most important point on which a purchaser should be satisfied is the hill-climbing power of the motor vehicle submitted to him. It is not only necessary that a car should take its full load up a steep hill, but it is essential for satisfactory touring that it should take its load up the steep hill at a good speed.

Many of the earlier cars were so under-powered (the engine-power being insufficient in relation to the weight of the carriage body and load) that on an incline of any steepness they could not pull their load at a speed of more than four miles an hour.

This matter is of urgent importance, and I propose to illustrate it very fully by showing the average speeds arrived at by one of these earlier cars and by a comparatively modern car respectively, over a distance of two miles, consisting of one mile up-hill and one mile down-hill.

If the old-fashioned car mounts the hill at four miles an hour and descends it at thirty miles an hour, its average speed for the two miles would be, in spite of the illegal and breakneck rush down hill, only a shade over seven miles per hour If, on the other hand, the modern car goes up the hill at ten miles an hour and comes down at thirty miles an hour its average for the two miles will be fifteen miles an hour. At the foot of the descent the modern car would be nine minutes ahead of the old-fashioned car.

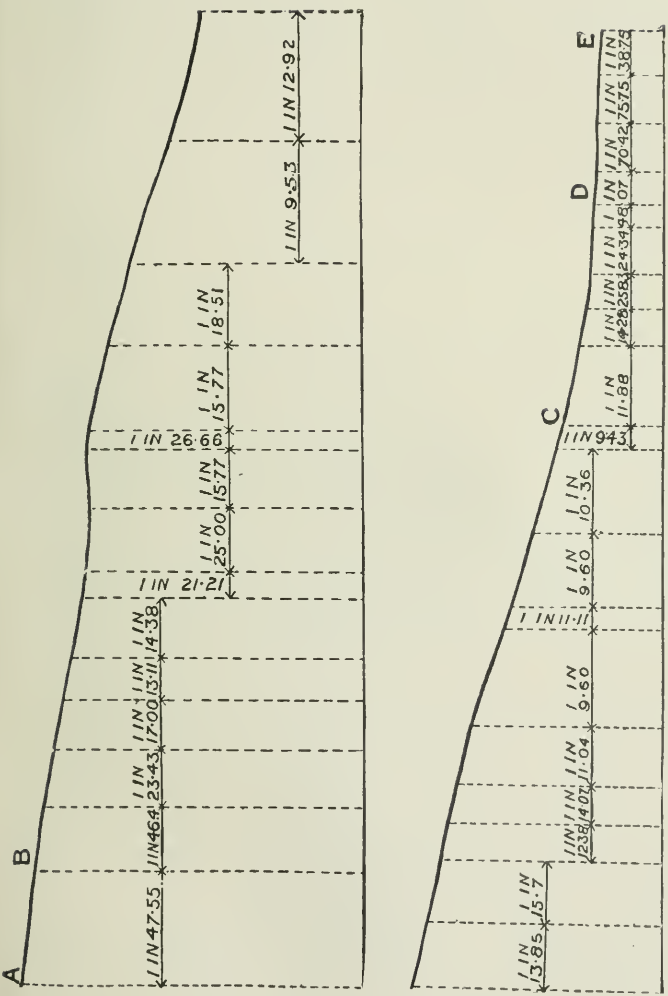
One may easily calculate what this difference would represent in a long day's run.

It is surprising to find that if a man who has been used to driving cars which go slowly up-hill changes to a high-powered car the temptation to rush down-hill vanishes. One's view of the road is reversed. Whereas in the under-powered car the temptation to rush down-hill came on one as a relief from the monotony of grinding and groaning up-hill, and consequently up-hills were dreaded and down-hills welcomed, with the high-powered modern car one pines for up-hills on account of the pleasure of annihilating them, and having arrived at the top the car is allowed to meander leisurely down the other side. Horses, bicycles, railway trains go slowly on up-grades. The modern motor appears to disregard the laws of gravity and to fly up-hill. The sense of conquest is glorious. The temptation to 'scorch' down-hill is gone. Undoubtedly the high-powered motor removes the temptation to excessive speed down-hill, and consequently removes a great danger. This is illustrated by referring again to our example. Supposing that the driver of the modern car wished to descend very cautiously, he could do so at six miles an hour and yet arrive at the foot of the hill a minute in advance of the old-fashioned car which ascended at four and descended at a speed of thirty miles an hour.

These illustrations will, I hope, bring home to buyers the necessity of purchasing a car which will ascend hills at a good speed, and of not being carried away by statements that a car will ascend 'one in four' without first ascertaining at what speed it will ascend 'one in ten.'

If a buyer finds that the car he is inspecting has not been submitted to the Automobile Club's 100 miles trial in which the speeds on hills are ascertained, he should insist on the seller carrying out a hill-climbing test in his presence.

Near London he cannot find a better ascent for this purpose than Petersham Hill, which leads from the Star and Garter Hotel at Richmond down to Petersham Road. The motor-car with its full complement of passengers should be timed from opposite the Dysart Arms in the Petersham Road,



Petersham Hill, Richmond

A. Junction with Queen's Road. B. Opposite main entrance to Star and Garter Hotel. C. Junction with Petersham Road. D. Opposite Fountain. Petersham Road. E. Opposite Dysart Arms, Petersham Road.

and the time should be taken again at the main entrance to the Star and Garter Hotel. This is a distance of 1,800 feet, having a total rise of one in fifteen, but at parts the gradient is as steep as 1 in $9\frac{1}{2}$. The following are the times taken by cars travelling at average speeds of from four to twelve miles an hour respectively between the Dysart Arms and the Star and Garter on Petersham Hill: 5 min. 7 secs. = 4 miles per hour: 4 min. 5 secs. = 5 miles per hour: 3 min. 24 secs. = 6 miles per hour: 2 min. 55 secs. = 7 miles per hour: 2 min. 33 secs. = 8 miles per hour: 2 min. 16 secs. = 9 miles per hour: 2 min. 2 secs. = 10 miles per hour: 1 min. 51 secs. = 11 miles per hour: 1 min. 42 secs. = 12 miles per hour.

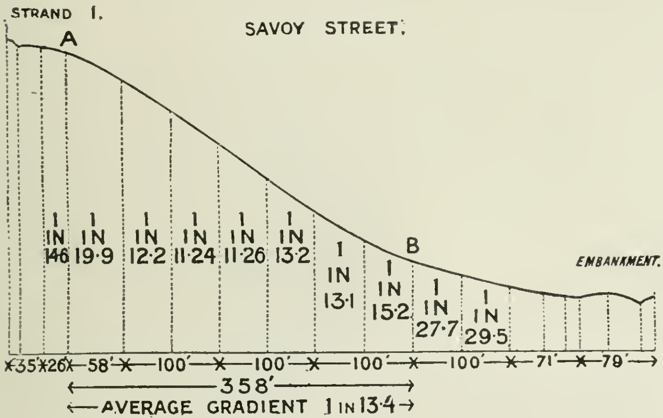
A contour of Petersham Hill is illustrated on p. 55.

Purchasers who live in hilly countries often ascertain from local surveyors what are the stiffest gradients on surrounding hills. They then go to London to purchase a car and ask the makers if it will ascend 1 in $8\frac{1}{2}$. An agent has been known to say 'yes,' and, in proof of this statement, the purchaser has been driven up to Savoy Street and has been told it is 1 in $8\frac{1}{2}$. In order to assist purchasers, the engineer of the City of Westminster has kindly supplied a correct contour of Savoy Street which is published (p. 57), and from this it will be seen that the average gradient is 1 in 13·4 and the steepest is 1 in 11·24. Another hill, a really steep one, has also been specially surveyed for the purpose of this book, and the contour is published (p. 58). This contour and the following particulars should be of considerable service to the purchaser from Devonshire or other hilly districts, and also to the maker of a good car, as the latter can prove by demonstration not only whether the car will go up a hill of known gradients but—a very important consideration—at what speed it will go up the hill.

The ascent to which I refer is situated in Richmond Park, and is usually known as the 'Test (or Broomfield) Hill.' On entering the Robin Hood Gate, the first turning to the left should be taken. A gradual and winding ascent leads to the foot of the steep portion. Time should be taken on passing

the second of two oak trees on the right,[1] the branches of which completely overhang the road. Time should also be taken at the last oak tree on the right at the top. The difference of altitude between these two trees is 75·03 feet. The average gradient is 1 in 11·3; and there are 72 feet having an average gradient of 1 in 7·8.

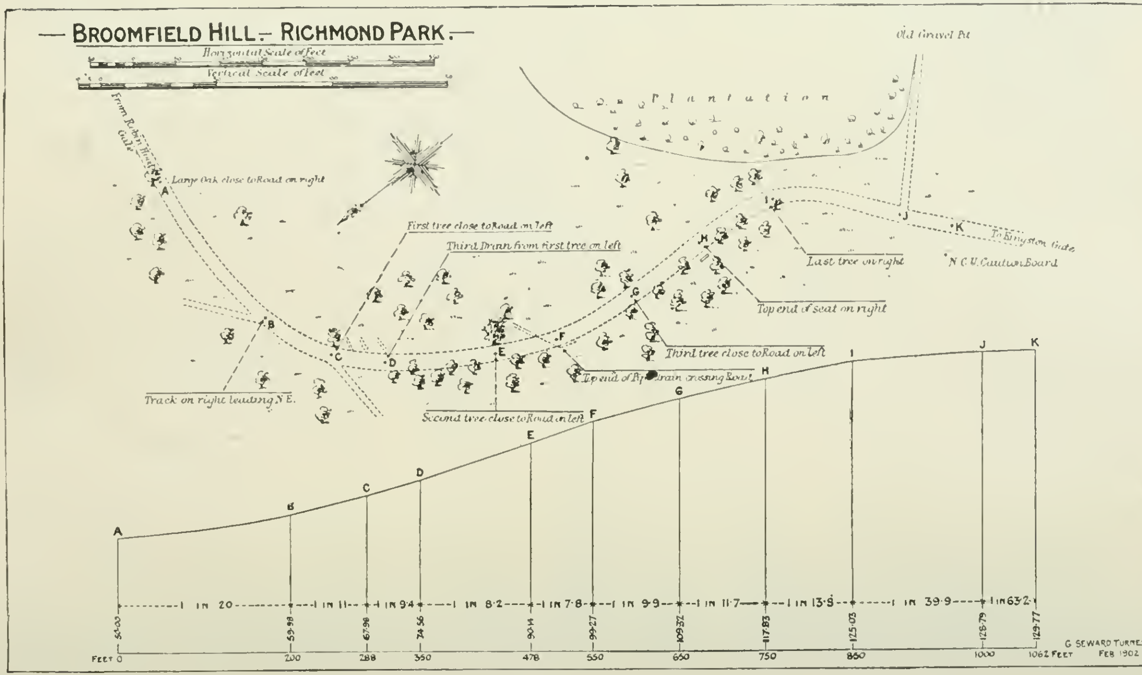
The following table shows the times taken by cars travelling at average speeds of from four to twelve miles an hour



respectively between the two oak trees above named on the Test Hill in Richmond Park :—

2 min.	25 secs.	= 4	miles per hour.
1 min.	55 secs.	= 5	,,
1 min.	36 secs.	= 6	,,
1 min.	22 secs.	= 7	,,
1 min.	12 secs.	= 8	,,
1 min.	4 secs.	= 9	,,
	57 secs.	= 10	,,
	52 secs.	= 11	,,
	48 secs.	= 12	,,

[1] Marked A on plan.


— BROOMFIELD HILL.— RICHMOND PARK.—
Horizontal Scale of Feet
Vertical Scale of Feet
Old Gravel Pit
Plantation
From Robin Hood Gate
Large Oak close to Road on right
First tree close to Road on left
Third Drain from first tree on left
Last tree on right
N C U Caution Board
To Kingston Gate
Top end of seat on right
Third tree close to Road on left
Top end of Pipe drain crossing Road
Track on right leading N.E.
Second tree close to Road on left
A
B
C
D
E
F
G
H
I
J
K
1 IN 20
1 IN 11
1 IN 9·4
1 IN 8·2
1 IN 7·8
1 IN 9·9
1 IN 11·7
1 IN 13·8
1 IN 39·9
1 IN 63·2
50·00
59·98
67·98
74·56
90·14
99·27
109·32
117·83
125·03
128·79
129·77
FEET 0
200
288
350
478
550
650
750
850
1000
1062 FEET
G. SEWARD TURNER
FEB 1902

Another hill which is fairly convenient to London, and is often used to test cars, is Netherhall Gardens, leading out of Fitzjohn's Avenue, near Swiss Cottage Station. This hill has been specially surveyed for the purpose of this book, and a contour is shown on p. 60.

PARAFFIN MOTORS

Many readers of the 'Badminton Library' will desire to know of cars which can be used where petrol is unobtainable. Messrs. Roots and Venables in England, Koch and others on the Continent, have for a long time studied the problem of the paraffin internal combustion engine. The advantages of motor-cars fitted with these engines for use in hot climates and places where petrol cannot be purchased are obvious. Ordinary lamp-paraffin can be found in almost any part of the globe.

SECOND-HAND CARS

I do not advise the purchase of a second-hand car, but if it is considered necessary to effect a very doubtful economy I urge attention to the following points :—

(1) Pay no attention to paint, varnish, and upholstery. These things cost a few pounds only, and often hide a multitude of defects.

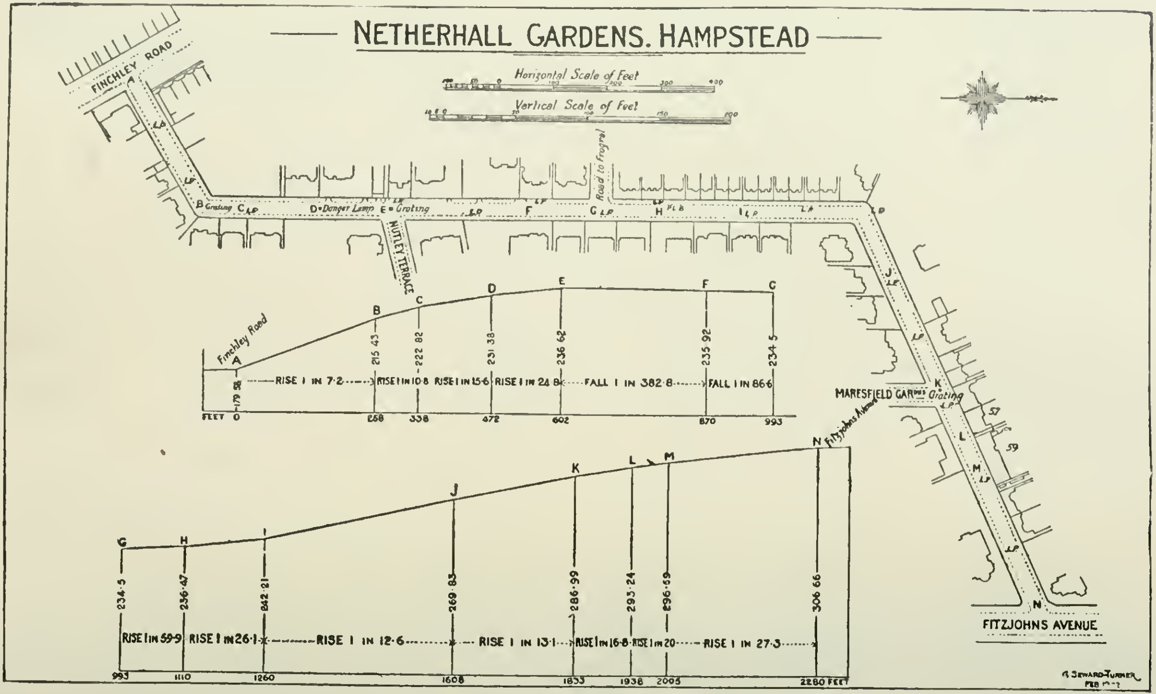
(2) Insist on a whole day's trial on a hilly road.

(3) Let the engine be taken to pieces after the trial, to ascertain condition of cylinders, gear, and bearings. Should the cylinders prove to have been heated on any occasion drop the idea of purchasing the car. Cylinders are often covered with aluminium paint to hide this fatal defect.

(4) See that the axles are straight and that the four wheels run true and parallel.

(5) Ascertain number and type of engine, and write to manufacturers for real date of issue.

(6) In buying a second-hand electric car look carefully to the state of the batteries. Batteries, like petrol engines, can



A. Line of Forecourt fence east side of Finchley Road. B. Drain-grating in the middle of bend. C. Opposite first lamp-post (L.P.). D. Danger lamp in the middle of the road. E. Grating. L. A point in centre of road opposite the party fence on the left between Nos. 57 and 59. N. The kerb-line on the west side of Fitzjohn's Avenue. P.L.B. Pillar letter-box. L.P. Lamp-post.

be 'faked.' Let batteries be discharged through a recording voltmeter and amperemeter, and see that the amperage of discharge is equal to the force required for running the car on a level road. See that the commutator is not worn.

(7) Second-hand steam cars of American make are worth little. Beware of them. Second-hand Serpollets are probably out of date. There are many about, and my experience proves them to be worthless. In the new type see that the boiler tubes are in good order, and have not been scraped for effect. See also that there is no play on the bearings of the cam shaft.

(8) Generally speaking, approach second-hand cars with grave suspicion. My remarks will be unpalatable to dealers therein, but this book is not written for them. It would be grossly unfair to a respectable body of tradesmen to stigmatise them as dishonest, but there are unfortunately many black sheep in the fold.

MOTOR ENGINEERS

A prime difficulty of the establishment of a motor-car is the chauffeur or engineer.

The perfect motor servant should be a combination of gentleman and engineer. He is a new type of man, and will require the wages of other engineers. I do not think that a competent, cool-headed, skilful, well-mannered head engineer will ever be obtainable for 30*s*. a week. On the other hand, the simplification of the motor engine and the establishment of *garages* will render the employment of highly educated engineers unnecessary in private establishments. As to public *garages*, some are well managed, others are not. Beware of those which offer to house your car very cheaply. They will make up the deficiency by overcharging you for repairs.

CHAPTER IV

DRESS FOR MOTORING

I. DRESS FOR LADIES

By Lady Jeune

My simple task in this volume is to discuss that side of the question which affects women very deeply: how to dress and equip themselves so as to be warmly and comfortably clad with as little disfigurement as possible. The fact that women should motor—if a verb may be employed—and care for it as much as they do is a great tribute to their lack of personal vanity, for, try as hard as they can, it is almost impossible to make the dress they have to wear a becoming one. In most of the sports and pastimes of women the dress they assume is arranged with a view to adding to their charms, and in nearly every case it can be both pretty and serviceable. In croquet, lawn tennis, skating, hunting, driving, or bicycling, the dress worn by women may be excessively becoming, as it can be made to show off the figure, and the hat or headgear is generally a delightful frame to the face—indeed, the fact that the athletic costumes of women are so picturesque is possibly one of the reasons which have made out-door sports so popular among them.

In the case of motor driving or riding there are two things only to be considered: how a woman can keep herself warm in winter and not be suffocated by the dust in summer without making herself very unattractive. Dress must be regulated

to a great extent by the speed at which she travels, and it is quite possible to wear a smart hat and pretty clothes if the pace is a comparatively slow one, such as is usual in the Park or in the streets of London. This chapter, however, has to deal with the more serious side of the question, how a

A long Coat showing Leather Waistcoat

The same buttoned up

woman should dress who goes on long journeys in every kind of weather, and at a high rate of speed.

The first consideration must be to keep warm, and the second – a no less important one—what head-gear must be worn

that will keep on the head, and not be blown off by the first gust of wind. The question of warmth must be considered from every point of view, and plenty of suitable clothing is absolutely essential. A warm gown should be adopted, made of a material that will not catch the dust, and it is also important to wear warm clothing under the gown; for unless such jerseys and bodices are worn, the wind penetrates, and it is quite impossible to avoid feeling chilled during a long day. The fatigue which is inseparable from many hours in the open air, and is also intensified by the rapid speed at which one travels, becomes greater as the day passes; with the increase of that fatigue a feeling of cold arises, so that unless a sufficient amount of warm clothing is worn the sense of exhaustion becomes very trying.

The best material for excluding the cold is leather, kid, or chamois leather; the latter may be recommended for lining the coat, and kid for the outside covering. This has, however, the disadvantage of being heavy and stiff, while chamois leather is softer and gives the figure more laxity. A coat lined with chamois leather and fur is the most successful of any, and the outside cover can be made in any pretty waterproof material.

The best coats that I have seen for motor-car driving are some which come from Vienna, and are both cheap and comfortable. The fur employed for the lining is opossum, which is both light and thick; they are to be had of any length, they button up the front, are double-breasted, and have two warm pockets placed crossways in front. The coat of which an illustration is given is excellent for the purpose, but it is more elaborate. It has, however, the leather waistcoat or undercoat attached to it, and is extremely comfortable. It can be made in any cloth or material. It has heavy fur which, while it looks smart, is a sure means of catching and retaining dust, and the great object to be aimed at in motor travelling is to find something which will not collect dust, for if coats, rugs, &c. get dusty it is almost impossible to get rid of it. The

longer a coat is the better, for it is round the extremities that the cold is felt as much as anywhere. Therefore a coat should be made loose enough to wrap round the figure and fold well over the knees. It is quite impossible to keep warm in a rapid motor journey except by using fur rugs, and they should be backed with leather, which obviates the trouble of beating the dust out of them at the end of the day.

Glengarry Cap

Difficult as it is, however, to keep warm and fairly clean as regards the clothes which should be worn, the real problem is how to keep a hat on. The head must be warmly covered and the hat small, for anything large or wide offers too much resistance to the wind, and gets quickly blown off. After many experiments I am satisfied that the picture given above shows the best head-dress for the motor-car. It is a blue Glengarry

cap pinned in one or two places to break the hard, straight outline, and to give a little height to it. It is light and warm, and worn with a long gauze veil, which covers not only the hat but comes over the ears, the wearer is as comfortable as possible. The veil can be varied from gauze in summer to a long grey Shetland cloud in winter. Grey is the best colour, as it shows the dust less than any other. The illustration depicts

The Veil covering the Face

the veil covering the face, and protecting it, if the wind is too strong and cold. The material for making the veil must be not less than two yards long, and three-quarters of a yard wide. It should be drawn well up in front, and pinned to the bonnet, then pulled down over the ears, and crossed behind, bringing the ends to the front, where they can be fastened in a bow under the chin; two or three pins should be put in behind to keep

it in its place, and it will, if properly pinned, remain perfectly tidy all day. It is necessary to have the veil sufficiently wide, so that there should be enough to fall down over the face if it is wanted. A long grey Shetland cloud is the best and most comfortable veil to wear in winter. The yachting cap has some advantages, but it is hard and heavy to the head. The best gloves to wear are white knitted worsted. These are warm and easy to wash.

There is one point interesting to every woman on which a few words are necessary, and that is what the effect of long days in the open, and the rapid passage through the air, must have on the complexion. It certainly does not improve it, but there is not much use in trying anything, except wearing a veil, to mitigate its evils. Many people use powder and grease to prevent the skin from getting red and hard.

Alas ! if women are going to motor, and motor seriously—that is to say, use it as a means of locomotion—they must relinquish the hope of keeping their soft peach-like bloom. The best remedy is cold water and a rough towel, and that not used sparingly, in the morning before they start. There is one other, the last, but perhaps the hardest concession a woman can make if she is going to motor, and that is that she must wear glasses—not small dainty glasses, but veritable goggles. They are absolutely necessary both for comfort and the preservation of the eyesight ; they are not becoming, but then, as I have tried to point out, appearance must be sacrificed if motor-driving is to be thoroughly enjoyed. Those who fear any detriment to their good looks had best content themselves with a quiet drive in the Park, leaving to the more ardent motorist the enchanting sensation of flying along the lanes and roads of our lovely country.

II. DRESS FOR MEN

By Baron de Zuylen de Nyevelt

President of the Automobile Club de France

When I asked why I had been invited to write on this matter I was told that it was because I had toured on my motor-carriage in many parts of the Continent, had met automobilists from many countries, and thus had had peculiar opportunities of picking up hints as to dress. It was added that in addition to this, as I am in the habit of spending a part of every year in England, I was in a position to know what would and what would not be acceptable to British gentlemen.

The dress worn by many motorists has been the subject of much irreverent ribaldry, and it must be conceded that, in many cases, the chaff has been merited. It is difficult to imagine anything more grotesque than the appearance of some whose enthusiasm makes them forgetful of their appearance. However, in order to drive with safety to the health in an open automobile, special garments are necessary. Clothes which may be quite suitable for a drive in a dog-cart are altogether unsuitable for use in an open motor.

When driving at twenty miles an hour the wind will actually pass through tweed overcoats and cloth garments; the air will be felt whistling round the ribs, and coats become distended behind like balloons. Speaking generally, therefore, the first requirement of motor clothes is that the stuff of which they are made should be air-proof, and the second that they should be so contrived as to prevent the wind from getting under them. A leather jacket and leather trousers are objectionable because the moisture from the body cannot escape, with the result that underclothing becomes dangerously moist and disagreeable. Leather may, however, be used as a lining to cloth clothes, provided that it is bored with many small holes through which

the moisture of the body may evaporate. A suit of cloth lined with punctured chamois leather will be found agreeable for both winter and summer. As most men like their clothes to be so fashioned that there may be nothing remarkable about them if they call on a friend, I find that men frequently have their motor suits cut in the ordinary way, Norfolk jacket or short coat with trousers or breeches and stockings; but the coats have one unnoticeable but very important provision, viz. they are so made as to button tightly round the wrist. Unless this precaution is taken it will be found that the cold air will blow up the sleeves, with the result that the hands, arms, and even body generally, will be made very cold. If the automobilist does not use a thick rug to protect his legs, gaiters should be worn with knickerbockers, and, if trousers are worn, they should be bound tightly round the ankles when driving. As regards underclothing it should be borne in mind that silk is perhaps the best material for retaining the warmth of the body.

We have next to consider the matter of overcoats. On the Continent a coat made of rough fur is worn, with the fur outside. It is found that, in addition to the heat-retaining qualities of the fur, such coats have the advantage of readily shooting off rain and of drying very quickly after a shower. They are provided with very high collars, which in cold weather are turned up, and almost surround the head. These coats have been a source of very considerable amusement to on-lookers and small boys in England, and it is a question whether they will be generally adopted; Englishmen appear to prefer a coat of Melton cloth lined with fur inside and fitted with a high fur-lined collar. Probably this garment fulfils all the purposes of the coat in which the fur is worn outside, and at the same time is less conspicuous. Moreover, it is held that the fur being interposed between the ordinary coat and the great-coat, permits of a certain amount of healthy ventilation.

In the summer, when the weather is very hot, provided that a thick suit of clothes be worn, a great-coat is sometimes unnecessary, except as a protection from dust. A light dust-

coat, made of a dust-coloured material and fitted with a high collar, will then be found useful, as after a dusty drive it may be taken off, and the ordinary clothes are left unsoiled. A light silk handkerchief tucked in over the collar is necessary to prevent the dust from working in around the linen collar and marking it.

Capes should be avoided, as more than one bad accident has arisen from a cape blowing up in a driver's face and thus temporarily blinding him, with the result that he has driven his car into the ditch. At the same time it is recognised that the best garment for protection from rain is that which most closely approximates to a bell tent. A coat is apt to let in water at points where the fabric is stretched; for instance, at the elbow. A tent-shaped coat on the other hand is not stretched at any point; consequently the water runs off it.

Many drivers object to using rugs, for fear that, inadvertently, the tail of the rug may work underneath the clutch or brake pedal. An automobilist will recognise at once that very dire disaster might result if he were suddenly to find himself unable to release his clutch.

A Parisian tailor who has specially studied motor clothes, recognising this danger, has designed a very ingenious rug, which is split in two, the two halves being so devised that each wraps round the leg, and is fastened at the bottom so as to form a fairly tight outer covering to the leg, with a rug-like wrapping round the body.

A London tailor has also recently made an excellent and efficient rug which may be used with safety for motor-driving.

A Piccadilly tailor, again, has built a special motor-coat, which obviates the necessity for a rug by being cut very wide in the skirt with buttons at the side. The garment is of good appearance, and somewhat resembles a German officer's great-coat. The motorist, therefore, has a choice of serviceable attire. One of the disagreeables of a long drive through rain is that the water is apt to accumulate on the seat of

the carriage, so that its occupants are virtually sitting in a small bath. I was amused to see some correspondence on this matter in the 'Automobile Club Notes and Notices' of February 4, 1901, No. 32, p. 197. Mr. T. G. Carew-Gibson there gave the following amusing account of a device in common use in the back country of Australia by coach-drivers and others :—

It consists of a flat, circular, leather-covered cushion about 15 inches diameter, by, say, 2½ inches thick, having a hole 2 inches or 3 inches diameter right through the centre. In fine weather you sit on the cushion, which—the coefficient of friction between trousers and cushion being greater than that between the cushion and coach seat—does all the sliding about (N.B.—the coaches are hung on thorotraces instead of springs), and saves both person and garments from considerable wear and tear.

In wet weather you put the cushion *inside* your coat before sitting down, and thus preserve a dry seat. Should you at any time leave the cushion exposed to rain, the water will not form a pool in the centre and saturate it, but will run away at once through the hole.

Just after the break-up of the 1888 drought, I one day struck the salubrious township of Booligal, in the Riverina District of New South Wales, and about 4 A.M. next morning, in a nice steady rain, issued forth from the 'hotel' to take my seat on the coach bound for Hay.

A minute later out came an old bagman who had also camped there, and seeing the driver standing dripping under the verandah, whilst the five lean and drought-stricken horses were being yoked up, asked him to wait a minute whilst he went across to the store. He shortly returned and climbed up beside us on the box, having under his arm a cheap American cloth table-cover, of a brilliant orange hue, and ornamented with a chaste design in bright pink flowers, and also a large gridiron, a fine specimen of the kind which stands on four short legs and has a long handle. He first proceeded to break off the handle of the gridiron, and remarking that he always liked to keep a certain portion of his anatomy dry, placed it on the seat and sat down on it: then borrowing my knife, he dexterously cut a slit in the exact middle of the table cover, through which he passed his head, observing that now he didn't care a —— when we got to Hay.

One of the principal waterproofers in the City of London has devised a kilt made of strong indiarubber material which is absolutely waterproof. This kilt is worn high round the waist, buttons down the side, and reaches below the knees. It is intended to be worn with gaiters, and under a great-coat. If the driver's seat becomes a pool of water the wearer of this kilt remains in blissful ignorance of the fact. Furthermore, the draining of water from the front openings of the coat—which is apt to take place at the point where the legs bend from the body—is shot off by means of this kilt. It has this advantage also, that in very cold weather if it be found necessary to alight from the carriage to make some adjustment, the hot envelope of air is still retained under it. On the other hand, if the driver be using a rug, he finds it necessary to throw it on one side, and to expose his warm legs to the cold air.

The most efficient contrivance which has been invented for protection from the weather is, however, the umbrella overall. This is made of indiarubber or other waterproof material, and is seamless. It is pulled on over the head, and elastic material closes tightly round the neck and wrists. The garment is far from picturesque, but on account of its seamlessness the most drenching rain cannot find its way to the clothes over which it is worn.

Snow Boots—viz. boots having indiarubber soles and cloth sides, which are made to slip on over other boots—will be found invaluable for motor-driving in cold weather.

Hats.—As to the matter of head-dress, it must be at once admitted that the peaked cap which has found so much favour amongst the chauffeurs on the Continent is not adopted, and, I think, never will be adopted, by British gentlemen for motor-driving. The Englishman appears to have a horror of anything approaching a uniform; or, in fact, of wearing anything which would draw the eyes of people upon him. Officers in the army and navy never wear their uniforms except when

they are compelled to do so, and after levees it is amusing to see the Briton crouching down at the back of his carriage, and driving to the nearest club, in order to get into mufti at the earliest possible moment. Almost the only time at which he indulges in a uniform is when he is on his private yacht, and free from the gaze of the crowd. He then wears a distinctive dress, with which the peaked cap is associated, but, so far as the roads are concerned, the peaked cap is only seen on the heads of the drivers and conductors of electric tram-cars, &c. The consequence is that the peaked cap is becoming recognised as the proper head-dress for a motor servant. The motor owner, on the other hand, as a rule wears precisely the same hat as he would wear for shooting, golfing, fishing and other outdoor sports—viz. the cloth cap, or soft felt hat.

Gloves.—For driving in cold weather, it should always be borne in mind that the gloves should be very large, so that when the hand is bent to grasp the steering-wheel the circulation may not be impaired by the veins being partially closed owing to the tightness of the coverings. Furthermore, a loose glove allows a cushion of warm air to be formed between the hand and the outer cover of the glove. Fingerless gloves lined with wool will be found very suitable for cold weather.

Gauntlets are worn by some motorists in order to prevent the wind from getting up the sleeves of a coat.

Goggles.—The goggles, or glasses surrounded by silk or some other material, which are worn by motorists are, as a matter of fact, almost indispensable. In the winter, driving in the cold with the eyes unprotected is apt to cause inflammation. In the summer, the dust arising from other vehicles is a source of considerable danger to the eye, and has been known to bring about granular disease of the eyelids. Furthermore, when driving at high speeds the blow of a small fly, let alone a bee or a cockchafer, on the eyeball is enough to cause temporary blindness. Silk or other material is attached to the glasses in order to prevent particles of dust, small insects, &c., from drifting in under the glasses. In winter it is found

desirable that the material attached to the glasses should hang down as low as the mouth, and thoroughly cover the temples and cheeks if the motorist should be inclined to neuralgia.

Generally speaking, there appears to be no reason why, apart from the goggles, a motor owner cannot dress in such a manner as thoroughly to protect himself from cold and at the same time retain so ordinary an appearance as to avoid public attention.

Oldsmobile

CHAPTER V

MOTOR CARS AND HEALTH

BY (THE LATE) SIR HENRY THOMPSON, BART., F.R.C.S., M.B. LOND., &c.

IT gives me particular pleasure to contribute to a book on automobilism, inasmuch as I am old enough to remember the steam coaches which were running in London in the third and fourth decades of the last century, and, at the age of nearly eighty-two, I am taking part in the revival of automobilism, and am in the habit of making journeys almost daily in my automobile.

I am asked to write concerning the relation to health of driving motor vehicles. Personally, I have found my drives to improve my general health. The easy jolting which occurs when a motor-car is driven at a fair speed over the highway conduces to a healthy agitation; it 'acts on the liver,' to use a popular phrase, which means only that it aids the peristaltic movements of the bowels and promotes the performance of their functions; thus accomplishing the good in this respect which arises from riding on horseback. Horse-riding has, however, the advantage of necessitating exercise of the muscles of the legs. This is one of the disadvantages of motoring, but I have found that it may be to some extent overcome by alighting at the end of a drive of twenty miles, and running smartly for about two hundred or three hundred yards. I make this a practice in relation to my motor drives. Remaining seated in one position, with little or no opportunity of moving the lower limbs, renders them very liable to

stiffness or cramp, especially in the case of elderly drivers, whose joints are less mobile and flexible than those of the young. The exhilaration which accompanies driving in a motor is particularly helpful to people who are somewhat enervated. I have known instances of ladies suffering from defective nerve power who have derived great benefit from the invigorating and refreshing effect of meeting a current of air caused by driving in an automobile. Veils of varying thickness, according to the temperature, should of course be worn by ladies, but much of the benefit to nervous patients is caused by the air blowing on the face. The facial nerves are acted upon with beneficial results well known to have a restorative influence on weak and so-called 'nervous' individuals.

Furthermore, the action of the air on the face, and the continual inspiration of fresh air, tend to promote sleep, and I should have no hesitation, speaking generally, in regarding daily exercise in a motor-car as aiding towards the prevention of insomnia.

To dwellers in cities the automobile is of great benefit, as it enables them in a short time to reach the fresher air of the country. It is difficult to exaggerate the necessity for those who live in the densely populated parts of cities and large towns to take every possible opportunity of breathing the purer air of the country. The air in towns is impregnated with carbon (smoke, i.e. particles of unburnt fuel). It is also, in dry weather, loaded with dust, a great part of which is composed of dried and pulverised horse manure. In wet weather, fluid manure from the same source is absorbed by and then exhaled from the road or wood pavement, with similarly injurious effects. These impurities are practically absent from the air of the country, and so access thereto is one of the great benefits which may be derived from the use of the automobile. I look forward to the day when Mr. Arthur Balfour's hope may be fulfilled—viz. when the perfected automobile will provide rapid and cheap transit for workers in cities to healthy homes in the country.

I have been told by men who are occupied long and closely with brain-work, that the automobile has filled a great want in their lives. They have found themselves too much exhausted to be able to take a long bicycle ride into the country; while railway travelling excites their overwrought nerves, and increases their sense of fatigue. The effort to catch a train at a definite time is in itself irritating and wearing to an over-worked system. No such effort is necessary to the owner of a motor-car who has a trustworthy driver to relieve him from the mental labour of watching the road, since he need have no fixed time for departure, but may call for his car whenever he is ready, or feels inclined to start. A drive behind a horse scarcely amounts to a recreation after the turmoil and worry of his work.

In the automobile, however, he finds ample sources of interest, amounting sometimes to a gentle and healthy excitement with complete rest and absence of fatigue from muscular exertion; without the bustle, noise, and sense of confinement which accompany railway travelling; together with the refreshment of novelty and suggested ideas occasioned by the contemplation of a continually changing panorama of scenery; at the same time enjoying the recuperating effect of breathing the fresh country air. One enormous advantage of automobilism lies in the fact that it is so admirably qualified to supply recreation for the modern worker.

Now let me give a few words of caution. The vigorous man who has been used to take exercise on horseback, on his bicycle, or on his legs, must beware lest the fascination of motoring lead him to give up his physical exercise. Unless he systematically maintains habits of muscular exertion he may find that he is putting on flesh, becoming flabby, and generally losing condition. Whether he possesses a motor or not, he must use his muscles regularly and sufficiently if he desires to preserve his health. The eyes also should be carefully protected by glasses with silk attached to them partially covering the cheeks, whereby the small flies and dust which

accompany road travel in the summer-time, and the cold winds of winter, may be excluded. Dust may set up irritation in the eyes and cause serious trouble, while driving in cold weather with the eyes unprotected may lead to similar conditions. It is a very good plan on returning from a dusty drive to wash the eyes by means of an appropriate eye-glass with a weak solution of boracic acid. Any respectable chemist can supply a solution of the proper strength to be used diluted with warm water. I always have a solution at hand in my dressing-room for the purpose.

Another chapter in this book deals with the question of dress, but I should like to impress upon those who adopt the luxury of motoring that it is better to be too warmly clad than insufficiently clad. A drive when one feels cold and fatigued may result in 'a chill,' which usually means a cold or cough more or less severe. Those who are learning to drive should be careful not to be out for long periods whilst they are beginners, as the strain of driving may cause unnecessary and harmful exhaustion. When, however, a driver becomes familiar with his car and driving becomes automatic this exhaustion entirely disappears. Of this, I must admit that I have no experience, having invariably relegated all the management of my car to an experienced driver, and reserved to myself the freedom of enjoying the incidents of the road and the scenery—may I say, *otium cum dignitate*?

In the summer season, when dust and flies will penetrate more or less the best form of goggles made expressly to prevent their intrusion, the occupant of a motor car will probably find his eyes, at the end of a long run, in a very heated and uneasy condition. The best remedy I can advise for this is the following; and I have it on my toilet table all the year round. Obtain a good four or six ounce stoppered bottle of clear glass with a wide mouth. Let it be perfectly cleaned before using it. Pour into it about half an ounce of boric acid in crystals; fill the bottle with warm water, say 100° Fah.; shake it well for a minute, and let it stand for another. You will probably find a small quantity of the crystals still undissolved at the bottom. The upper portion, or 'supernatant fluid,' is that which you have to deal with. Pour off half an ounce into a graduated clean glass ounce-measure, such as chemists use, with a lip to facilitate pouring. The quantity named is to be used with an equal portion of plain warm water; if distilled, so much the better. Use the mixture by means of the ordinary eye-glass, sold for the purpose, to each eye two or three times, throwing the head back well, and opening and closing the eye repeatedly in the liquid. This will remove the numerous particles of every kind which have entered the eye, destroying bacteria &c. On every occasion on which this has to be done, the whole of the face, but especially the eyebrows and eyes, should be first washed well with plain warm water.

CHAPTER VI

THE MOTOR STABLE AND ITS MANAGEMENT

BY SIR DAVID SALOMONS, BART., M.A.

AT the present time probably not one per cent. of the owners of motor-cars have a suitable coach-house for this new class of vehicle. They are generally placed in sheds or outbuildings, more often damp than dry, or in coach-houses built for horse-drawn carriages. Few recognise that the motor-car is a far more delicate article than the horse-drawn carriage, most people having grown up in the common belief that anything to do with machinery is strong, and will bear knocking about. It is well, therefore, at once to disabuse the mind of such ideas.

The abode of the horseless carriage requires to be superior in many respects to the shelter given to the machineless vehicle. It must not only be perfectly dry, but must have a variety of accessory arrangements for dealing with all parts of the machinery—for cleaning, adjustment, and repairs. A water supply, and a source of light safe in the presence of explosive gases, are essential. The space must not be too cramped, and plenty of light should be obtained through ample windows during the day.

The machinery must, from time to time, be examined from below. This can be effected in one of three methods :—

(1) By the attendant lying on his back under the carriage, a proceeding which does not commend itself.

(2) By a specially arranged platform, wherewith the carriage can be raised from the ground to enable a man to get below the vehicle without discomfort.

(3) By means of a pit sunk in the ground, by which a man finds himself comfortably situated below the car. This pit may be small, and the carriage gradually advanced to give access to all parts of the machinery, or, what is best, it may be a long pit, so that the car can be examined throughout its length. This method will be evident to all as the best.

A well-built motor-house should cost nothing in the upkeep, beyond the painting of the doors occasionally. A cheaply built motor-house implies an annual expenditure combined with vexation, and after a few years a patched-up place is the result.

The writer has given great attention to motor stables. It may not be out of place, therefore, if the methods adopted at Broomhill, near Tunbridge Wells, are described in detail.

The stabling consists of five long narrow rooms, one made to contain three small cars, another two large ones, the third two small or one very large car, the fourth room a small car, or may be used as a cycle house; and the fifth room will accommodate two moderate-sized vehicles, or can be used as a washing-house in bad weather. One of these resting-places is somewhat modified to enable repairs to be carried out.

This latter house will be described, since, if only one shelter existed, it should be so constructed. It is twenty-eight feet long, ten feet six inches wide, walls eleven feet high. The whole construction is fireproof, with the exception of the ceiling, which is tent-shaped and match-boarded, having a long skylight on the north side in order that the direct sunlight may not enter. The skylight is Mellow's patent glazing, which never leaks and does not require to be painted. The glass is one quarter of an inch thick to resist a hailstorm. Some years ago a hailstorm of extraordinary violence occurred around Tunbridge Wells, and glass to the cost of thousands of pounds was broken throughout the district. Many of the hailstones measured over an inch in diameter. The experience at Broomhill was that all glass a quarter of an inch thick

escaped, and this was a lesson learned for the future. The skylight is barred, to keep out evil-disposed intruders, and a tick blind can be pulled down to subdue the light when required. There was no special object in making the roof fireproof, since the side walls are high. The entrance doors consist of a pair, practically the whole width of the house. Collinge's hinges are used, being the strongest.

The floor is made of Victoria stone laid on brick sleeper walls, which are not built upon the ground, but upon a six-inch bed of concrete covering the whole of the bare earth. Consequently the floor can be kept perfectly dry. The walls are all double nine-inch brickwork, built in cement, with two inches of air-space between; so that, however wet the weather may be, the interior wall is never damp; and they are carried above gutter level so that any fire may not extend. The bricks employed for the interior and exterior are neatly pointed close-grained white brick having a texture the nature of porcelain, and waterproof. For the interior, cemented walls would have answered the purpose, but the pointed brickwork looks better. The roof is boarded, felted and slated, while below the rafters is a lining of matchboard. By this means the roof is as damp-proof as the walls and floor. This method of building is best adapted to keep out variations of heat and cold, since stationary air is an excellent non-conductor. The only escape for heat is through the skylight, but in very cold weather it is only necessary to pull the blind down, and an equal temperature can be maintained.

In the centre of the floor, and extending almost the whole length of the house, is the pit, which is about eight feet deep. This is made excessive in depth for a reason which will be given in due course. The width of the pit is somewhat narrower than the distance between any of the motor-car wheels. The mouth of this pit is a strong timber frame, the wood being four by three inches, and rabbeted the whole length of the two inner sides. Boards two inches thick and two feet wide drop in the rabbets, each board having sunk

iron rings on the surface. The object of this arrangement is that when all the boards are dropped into place the pit will be completely closed, and by means of the rings any one or more covers can be raised as required, in order to open the pit for an observation from below.

The chief object to be attained by building several separate motor-houses in the place of one large one is that wall space is gained, which is a matter of no small importance when it is remembered how many spares are required in connection with motor-carriages. The walls of the motor-house under description are furnished in the following manner. Near the doors on either side are ranges of small shelves upon which are placed the most necessary tools and other small items which are almost invariably required when a carriage is to go out. The remainder of the wall is furnished with larger shelves to carry testing apparatus, pumps, a variety of tools, and such spare parts as are not carried in the vehicle, as well as oil, &c. There are also brackets of metal or wood, in the shape of the arc of a circle, upon which are hung spare covers and air tubes. Another item is a small chest of drawers, each drawer being divided, as are those used by watchmakers to contain small parts in an orderly manner.

This house is prolonged beyond the space necessary to stand the carriages, to the extent of about six feet.

This space is occupied by a work-bench, vice, and hand-drilling machine, and upon the end wall are racks for all the tools necessary for making small repairs, and a complete set of duplicate keys, so that when the adjustments are made it will not be necessary to turn out the contents of the car. There is likewise apparatus suitable for soldering and brazing by gas or by benzine lamps, the gas being used when there is no danger, while in the other case the benzine lamp is employed outside the motor-house so as to be in the open air.

In the corner, by the side of the bench, is an iron circular staircase which leads down to a small basement, lighted by a glass in the motor-house floor, where large spares are kept, and

any special tools &c. which are rarely required, such, for instance, as a grindstone, also large reservoirs of oil. This basement has a door which leads into the pit. It will now be seen why the pit is made so deep; it can be readily entered without obliging anyone to stoop, the doorway leading into it being the usual height, viz. about six feet seven inches. In order to reach the cars conveniently two trestles are provided in the pit, across which are placed also some narrow planks, and there is a small pair of steps for reaching this platform. There is a spare set of trestles for a different height, in case the level should require to be altered. At the entrance door a piece of stone runs across the threshold, about two inches above the floor line, to keep any water from flowing out. The concrete bottom of the pit slopes towards a point where a gully is situated. Consequently any water in the pit flows towards this gully and drains off.

The floor of the motor-house itself requires no gully, because it inclines slightly towards the entrance doors, so that when it has to be washed down the water flows to the outside. Of course the pit can be entered from above if desired.

Plans of the motor-houses at Broomhill are here given to scale, as they will render the description clearer, and show all the arrangements at a glance (see figs. 1 and 2). There is also a picture of the motor-houses taken from a photograph in fig. 3. The fifth house is not seen in this picture.

The motor-house is illuminated by means of electric light, connectors are placed in the walls on either side, and also in the pit, for portable electric lamps which are most necessary for making examinations. One of the best forms of lamp and lamp-holder which have ever been devised is that made by the Edison and Swan Company, and intended for the examination of the interior of barrels. The shape of the lamp and the nature of its protection are such that it can be inserted between all parts of the machinery where a couple of inches of space exists. There are also the safety lamps using benzine supplied by Messrs. Carless and Lees, which can be used

—The Motor Carriage Houses, Broomhill—

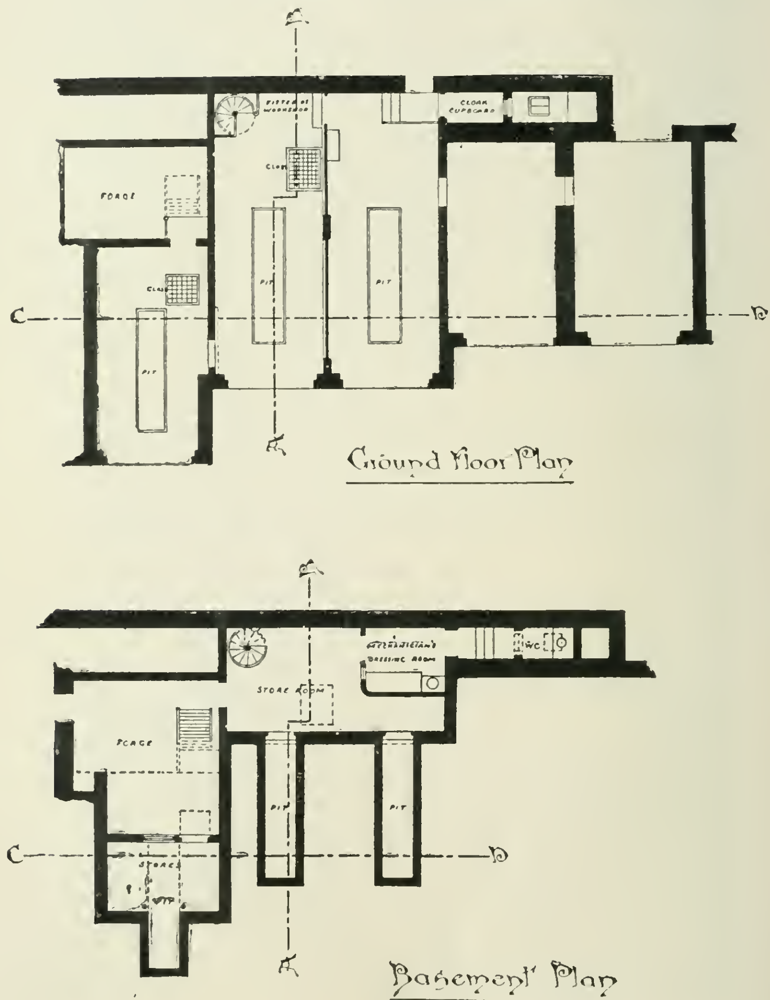
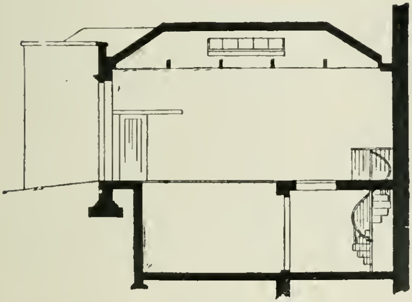
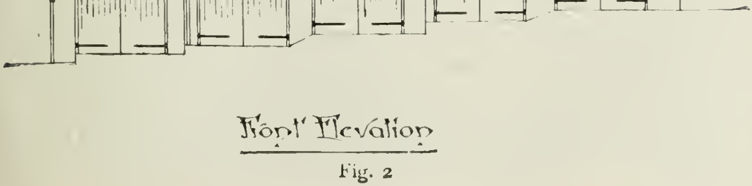


Fig. 1



Section on line AB

Section on line CD



Front Elevation

Fig. 2

if an examination has to be made in the absence of the electric light when benzine vapour is likely to be about. In the motor-house there are three tanks which hold about six gallons each with self-contained pumps. Two of these contain oil, one being thick and the other more fluid. The third is a seamless steel barrel which holds benzine. There is also a large metal bottle with a screw top, in which is placed any old benzine that is used for cleaning purposes. The main store of petroleum spirit is at a considerable distance from all

Fig. 3.—The Motor-houses at Broomhill, Tunbridge Wells

buildings. One of the neatest types of self-contained oil reservoir and pump is that made by the Richter Oil Economising Company of Bradford. Many other varieties are in existence, but none of those with which the writer is acquainted is so well finished.

The roof of the house is strengthened at certain points by cross timbers which support two small H girders, and carry iron frames to which are attached pulley blocks. These little frames can be slid along the girders in the direction of the length of the carriages below. By means of this arrangement

a carriage can be lifted off the ground, or any heavy portion of the machinery raised from the car without difficulty. There is also another use—viz. that with a dynamometer the weight of a vehicle can very fairly be estimated by lifting first the fore part and then the hind part just off the ground, and adding the two weights together.

If a pit does not exist, such an arrangement can be made to take its place, by raising the car to a convenient height above the floor.

A zinc tray about four feet long and about six inches narrower than the track of the car should be put under each vehicle to catch the drip, and for placing dirty waste in. In this manner cleanliness is cultivated. Wedges are also required for placing before and behind the wheels of a car when it is desired to keep it immovable.

It is money saved to have duplicate special tools in the motor-car house, as a great deal of wear and tear to the cars is avoided, due to the constant opening and shutting the drawers and cupboards to obtain the tools therefrom. The tool cupboard in the motor-house should also contain a complete set of all the spares which are generally carried in the cars, apart from other duplicate portions which it is usual to keep in stock, as nothing is more annoying than for a driver to find himself miles from home when some little spring or other matter may be required, and is found to be absent because it had already been used and a new one had not been put back in the carriage. In short, it is a good rule for the mechanic to have strict orders never to use a tool or duplicate part in the car except when on the road.

The ventilation of a motor-car house has not so far been referred to, for in reality it is almost unnecessary. The constant opening and shutting of the large doors give ample air, and if the tanks and joints on the car are kept tight, as they should be, no smell of benzine gas will be found at any time present. At the same time it is desirable that ventilation should exist, as it may be necessary to clean the cars with the

doors closed in bad weather. Large brass gratings capable of being shut should be placed in each of the upper portions of the entrance doors, and these will be found sufficient for the purpose.

It is also desirable to warm the motor-house. This is done at Broomhill by means of hot water. In many cases this method may appear difficult to carry out, and it is no uncommon practice to leave a gas-burner alight to keep out frost or to warm the room for the attendant when the weather is cold. Such a proceeding is clearly not desirable when there is a risk at any time of the presence of an explosive gas. Very simple heating arrangements by means of hot water can be purchased, some using gas and others burning petroleum as the source of heat. The little boiler in this case would be placed outside the motor-car house in a small brick shelter, and the pipes carried through the wall to the coil or coils in the usual manner. For a motor-house such as that which has been described, the apparatus would not cost more than from 5*l.* to 10*l.*, according to the character of the one selected.

In every motor-car house there should be two or three tinned-iron open boxes, of the nature of waste-paper baskets, about one foot square and two feet high. One of these should be kept filled, with dry sand, and contain a small shovel. This is useful, in case any benzine should catch fire, to smother the flames. The others are required to throw any waste substances into. Also on the wall there should hang two or three pails, kept full of water, to be ready in case of fire. It must always be borne in mind that water must not be poured on burning benzine, since the spirit would float upon the water, and in a burning state flow all over the place, thus increasing the danger.

There are also important points to be attended to inside the motor-house apart from the building. Always buy the best waste. It costs but little more than the bad quality, and lasts double the time, while it is generally free from dust and grit, and if great saving be desired, it can be boiled down

A MOTOR-HOUSE IN LONDON (1902)

with soap and soda for use again. A common quality of woolly waste should also be employed, simply for mopping up oil, not for cleaning purposes. It is undesirable to store a large quantity of oily waste for fear of spontaneous combustion. Sponge cloths are a desirable accessory for cleaning, and for polishing up what are known as 'Garlio' cloths are the best. They are made of pure silk, and do not get greasy to the touch; the cost also is low. The panels of the carriage should be cleaned with good chamois leather. Inferior qualities will scratch the varnish. The various brushes &c. required for cleaning are much the same as for a horse-drawn carriage. A great economy is effected by having a separate receptacle for old dirty oil, to be used only for cleaning purposes. Care must be taken that oil does not fall on any part of the pneumatic or solid rubber tyres, as it soon destroys the rubber. Boiled linseed oil is an excellent material for getting up the varnish, and petroleum sold under the name of kerosene will work wonders on varnish work and enamelled metal when all other means fail.

To keep a carriage in good order continual touching up is essential, not only where little chips of paint have been broken off, but also on the engine to give it a respectable appearance. No better material exists in the way of general paints than the Griffiths' enamels, which dry almost immediately, and are acid and heat proof and very hard. The black enamel is well suited for the over-heated portions of the engine, since it keeps its colour, unless the metal is brought to a red heat. Many kinds of aluminium paint have been tried for engines, and the majority have been found wanting. The paint which meets with perfect success in all respects is that made by Messrs. Ripolin of Paris. It is expensive, but the material goes a long way. The paint is used extensively abroad for the purpose indicated, and for decoration. With aluminium paint it is always desirable to give a final coat of Griffiths' transparent varnish. This will enable the owner to wash his engine at any time without in any way altering its appearance from that of being brand-new.

It is fatal to fold up the air-tubes and covers of the

pneumatics for any length of time, or to allow them to be exposed to too great cold or heat. Therefore the air-tubes and envelopes should be hung on the brackets on the wall, and the air-tubes should be kept inflated to a small tension. Since, as has been stated, no direct sunlight reaches the house, danger from excessive heat is avoided. Besides, the heat of the sun might burst the air-tubes on the vehicles standing in the house, or even prove a source of danger to the benzine reservoir by heating the liquid. It is advisable that air tubes, covers, and all rubber goods should be kept in the dark; to effect this any suitable material should be hung over such perishable articles.

Money is not wasted if the owner of the car purchases five jacks for every carriage, one to carry on the car itself, and four to be used in lifting the wheels off the floor, no matter whether the tyres are furnished with pneumatics or solid rubber. Of course, this proceeding would not be resorted to except when the carriage is left for some considerable time without being used, and this practice will greatly prolong the life of the tyres.

All tyres should be repaired at once, and not left for chance moments.

It is usual to wash the horse-drawn carriage directly on reaching the stable, because the mud can be more easily removed when wet, and without the risk of scratching the varnish. This process, however, cannot always be resorted to in the case of a motor-car, on account of the machinery being hot. It is therefore desirable to wet the mud well before removing it. A large Turkey sponge is best for cleaning the body and wheels of the car, and after washing, everything must be dried with sponge-cloths or leathers, according to the nature of the parts to be wiped. The engine itself, and any other working parts, are better cleaned with damp sponge-cloths and finally wiped over with oily waste. The bright parts are cleaned with selvyt, leather, or other suitable material. In no event must water be dashed over a car after the manner of cleaning ordinary carriages, although a hose is convenient for washing, since the water can be carefully directed to the required points.

It is almost the universal practice abroad to wet the clutch and brakes. At times the leather on the clutch (when it exists, as it generally does) becomes very polished, and is apt to slip. Sometimes dust or grit gains an entrance, and prevents it from gripping. Water cleans, expands, and roughens the leather without injuring it. Some owners clean their clutch with benzine. This practice is, however, objectionable, because the volatile portion of the benzine evaporates, and invariably leaves behind traces of oily matter, since perfectly rectified benzine would be too expensive to use, and would probably mean that a shilling would be spent each time the clutch was cleaned. It will be seen, therefore, that it is only a question of time when the clutch will become lubricated. However, if oil should by chance get into the clutch or on the brakes, this must be removed with ordinary benzine; but the occurrence should be rare if proper care is taken. By these remarks it must not be supposed that the clutch and brakes should be wetted daily. Once a month, or less often, is sufficient, even when a car is used constantly. On the road also, if a clutch does not act, due to slip, a small dose of water puts matters right at once if the mechanical portions are in order. It is necessary to point out that neither water nor moisture should come in contact with any of the electrical portions when they exist, i.e. primary battery, accumulator, coil, magneto &c. should be kept perfectly dry, also all conductors, insulators, and other electrical apparatus. The moisture itself, if the water is pure, will have practically no effect on the working of the apparatus, because this liquid is a very good non-conductor. Danger enters by the adhesion of dirt, due to the moisture, which causes the current to leak.

Every car should have mackintosh rain-covers, neatly made, so as not to be disfiguring, for use in wet weather; also dust-covers, which are useful on many occasions. In damp weather the carriage should be left entirely uncovered when standing in its house, since the covers become moist, and the carriage is enveloped in a wet cloth, when in a short time it will be found that all the leather parts have become mildewed. A

thermometer must be placed in the motor-house, for observing the temperature. In the one described it will be noticed that the mercury will not fall, in the coldest winter, below fifty degrees Fahr. or rise, in the hottest summer, above seventy degrees Fahr.

It is of vital importance that frost should be kept away from the motor-car, in order that the circulating water shall not freeze, and possibly burst some part of the apparatus. To empty the water daily in winter-time is a vexatious proceeding, because when it is replaced there is often the difficulty of restoring the circulation owing to air becoming lodged in the pipes or elsewhere. Quite apart from this consideration it is desirable to keep the same water as long as possible in the circulation apparatus, thus to reduce deposit in the tubes and not disturb any rust that may exist. If the water is removed daily, various pipes and other portions made of iron, 'thin out,' on account of removing so frequently the thin layer of rust which forms. When the apparatus is in use the circulation is not sufficiently violent to detach the oxide, and the thin coat preserves the iron below, being insoluble in water.

Thus it will be seen that the small expenditure on a hot-water system, and the cost of running it, is money saved in the end, and many a break-down owing to bad circulation will be avoided. It may be desirable for the benefit of those who do not know where such small heating apparatus may be obtained, to give the names of two or three firms who supply the requirements, viz., Messrs. Keith of Farringdon Avenue, E.C., Messrs. Crompton and Fawkes of Chelmsford, and Messrs. Fletcher of Warrington.

In the early days of motoring, it was the practice to put glycerine in the circulating water. This was discontinued at Broomhill years ago, because however pure the glycerine was, in a short time a dark-coloured greasy slime was formed which clogged the pipes and pump. Theoretically no such substance should arise from the addition of glycerine, and it may be due to the 'treacly' nature of the mixture that all dirt &c. in the tank, pipes and jackets gets picked up and circulated.

It is very difficult to draw a line between stable management and motor management. Probably, apart from the cleaning of the car, oiling the bearings and grinding the valves come within the province of the stable attendant. The oiling arrangements are so straightforward that there is little need to give special instructions under this head. It is, however, important to count the exact number of oil holes and grease cups existing in any car, and to have this painted in the car somewhere out of sight, giving instructions to the attendant to count up as he oils round. In this way no place will be forgotten.

When any difficulty occurs with a car many drivers at once accuse the electric ignition, when it exists, and next the valves, for the default. The unfortunate valve comes in for a great deal more abuse than it deserves. The less grinding they are given the better. When the operation is necessary of course it must be done. If the car is used daily, for say eight hours, and the oiling of the cylinders has been properly adjusted and not too profuse, it will be sufficient if the valves are removed weekly, to be wiped over with an oily rag, and then cleaned with a little heavy petroleum or benzine. If it should be observed that the bearing surfaces are pitted, then grinding should be resorted to, but this will not often be the case with experienced owners.

It is a very simple matter to grind the valve by adopting the following process. To give an example, we will consider the case of one valve, since it will apply equally to the others. The valve itself must be rendered free by the removal of all springs, and a little emery of the finest description, almost like flour, should be mixed up into a paste with oil. The bearing surface of the valve must then be coated with a thin layer of this paste by means of the finger, and placed upon its seating. It will be observed that there is a slot in the valve ready to receive the screw-driver. This tool is now employed in twisting the valve right and left, at the same time pressing it down on its seat with moderate force, turning always

to an angle of say forty-five degrees to and fro. From time to time turn the valve a little round, and continue the operation, the object being not always to grind in the same place. When this work has been continued for the space of a minute, the valve should be removed, and the rubbing surface on the valve itself, as well as its seating, be examined to see whether the rubbing is equal at every point round, and that the pit marks are now absent. Should this be the case, the operation is concluded. If not, it must be continued, using a little more of the emery paste until the desired result is obtained. Every trace of emery must then be removed by means of rags or waste wetted with petroleum or oil, and on no account should any remain, for the reason that it might enter the cylinder, bearings, or some other part of the machinery, and set up a friction which is hard to remove, since emery particles will embed themselves in the hardest steel. The emery rags and other things which may be employed for grinding valves should be kept apart, to run no risk of emery dust entering any rubbing parts of the motor.

Nothing is so destructive to the valves and cylinders as running the engine with the ignition 'retarded.' Great heat is developed and the valves become badly burnt, as does the upper part of the cylinder. Therefore, it is most important to 'advance' the ignition as soon as the engine has been started.

It is desirable that all benzine which is placed in the car, and all oil which is used, should be entered in a book, say once a week, in order to prevent extravagance and waste, and all storage tanks should have a gauge-glass marked in gallons or litres, in order that their contents may be observed. These gauge-glasses must of course have taps, or the breakage of a tube would empty the contents. The owner should once a month, or at any other suitable time, see by the book how much has been removed from the tanks, and by comparing this with what remains he will be able to judge how matters go.

It is desirable that any repairs, small or great, should be

attended to at once. This is the only way to keep a car ready at all times for use. Every car on being delivered possesses certain faults which the owner should remedy. It is true that the faults are details, and consist of omissions by the makers on account of expense, in consequence of trade competition, which would make their car appear more expensive than that of some rival. The public as a rule would not appreciate the little advantages for the extra expense incurred, though the want of them is felt later on. It is impossible to detail the whole of the points, since every make of car varies to some extent, but the lines upon which the owner should proceed may be indicated.

Every portion of the machinery should be arranged, as far as can be done, in such a manner that removal can be effected upon the road without use of tools, or with the least number. To give a few examples :—If burners exist, in order that the platinum tubes may be replaced without extinguishing the burners, additional taps of more perfect make should be provided in lieu of many of those which do not cut off with certainty, due to their construction. Extra taps in the course of the benzine tubes should be added, so that the fluid may be cut off at more than one point in case of fire. The nuts should be changed as far as possible to certain gauges to diminish the number of keys required. The locks of drawers and cupboards throughout should be passed with one key. Every nut on the car should have a spring washer placed under it, and the end of all bolts and studs pinned where possible. All break rods and clutch rods should be cut and joined together by means of a right- and left-handed screw coupler, with lock nuts on the rods, in order that adjustment may be made on the road with despatch, and the best tensions for these rods be obtained without trouble. The sparking plugs should carry a device so that the wire may be immediately disconnected without unscrewing a terminal. A device somewhat similar to the placing of an electric glow lamp into its socket answers well. All these details and many others which

suggest themselves according to the type of car, should be attended to, and they will repay the owner in a very short time.

The careful storage of benzine is a very important matter. No licence is requisite for the benzine carried on the car, which must not exceed forty gallons. If all reasonable precautions are followed, there will be no difficulty in obtaining a licence for the general storage. The benzine-store at Broomhill is constructed in the following manner: It is a lean-to house eight feet long, three feet wide, seven feet

Fig. 4.—Benzine House

high in front, and nine feet at the back. All the walls are of nine-inch brickwork, and the bricks in the side walls are so laid that the ends of them do not meet, in order to allow a free current of air to pass through. The fourth side is filled in by a pair of doors lined with iron. The roof consists of corrugated iron laid on T iron. The floor has a bed of concrete six inches thick. The sill is of such a height that if the tank or tanks were to leak, and let out the whole of the liquid, it would still be retained within the house. In order that this sill should

not be inconveniently high the floor is sunk. In the case referred to the sill is about six inches high, and this floor tank, so to speak, is almost filled with sand to act as an absorbent. There are two closed tanks, each of which holds 300 gallons. The inlets and outlets of each tank are arranged thus: a pipe issues from the bottom of the tank with a stopcock, and is only used for emptying the tank completely and removing the dregs. Another tap is placed six inches from the bottom, and is the one used to draw from. Another pipe with a stopcock

Fig. 5.—The Hon. Evelyn Ellis's Motor-house at Datchet

is inserted three inches from the bottom and at the side, to carry the gauge-tube. The gauge-glass has a scale by the side of it marked off in gallons and litres. Close to the top of the tank is a large hole with screwed plug. Into this is screwed a pipe which carries a suitable funnel for filling. There is also a small tap inserted at a suitable height, and attached to this is a pipe which passes through the tank and upwards to the top, where it is open; this is used as an air outlet when filling the tank. All the fittings are arranged on the front side,

and when the doors are shut they come close to them so that the person who attends to the tanks stands outside. On the tanks are painted in large letters the words, 'Highly Inflammable.' The building is situated a very considerable distance from other structures, and kept locked. An illustration of the benzine-house is shown in fig. 4.

An inexpensive and safe method for the storage of benzene is to bury a closed galvanised tank in the ground. The hole ought to be bricked round the sides, also the bottom, better to preserve the tank ; and there should be no drain of any kind provided, as this proceeding might lead to danger in the event of a leakage. A suitable pump is employed to draw out the spirit as required. Over the top a small movable roof in sheet iron is recommended.

The owner of a car must always remember that the best master of the mechanism is himself, and he should therefore take care to conquer all its intricacies and difficulties. Any time and patience that he spends in this manner greatly increase his power, and they are not wasted on any particular car, for nine points out of ten are common to all types of motor-carriages which are worked upon a similar system.

There is no need to deal with steam and electrically driven cars specially under the head of 'Stable Management,' because all the above remarks apply, excepting those which have special reference to cars carrying motors of the gas-engine type.

Fig. 5 represents the stabling of the well-known motor-car owner, Mr. Evelyn Ellis. He places his pit outside. When this is done a wooden or metal rail must run along each side of the pit as seen in the picture, to act as a guide for the car.

CHAPTER VII

THE PETROL ENGINE

BY R. J. MECREDY, EDITOR OF THE 'MOTOR NEWS'

EVERY motor-car owner, whether he can afford to keep a mechanic or not, should make a point of studying and thoroughly understanding his engine. It is not merely that this will save him trouble and emancipate him from the tyranny of the skilled mechanic, but it will very materially increase his pleasure in the pastime, for the study of the engine affords almost as keen enjoyment as the actual driving.

The man who is uninitiated is likely to regard with despair the prospect of ever being able to understand the apparently complex machinery which propels his car. In reality it is exceedingly simple. Very little study will enable him thoroughly to grasp its principles, and after that the rest is merely a matter of common sense. When he has once learned how the engine works, and wherein it is likely to fail, he will quickly diagnose troubles which would otherwise prove insurmountable.

Of course, if one can afford it, it is desirable to keep a skilled mechanic, but it is an enormous advantage to feel that one is independent of his services, and cannot be 'taken in,' as is the ignorant novice. A mechanic, however, is by no means necessary—an ordinary handy man can quickly be taught to clean and lubricate, to keep the working parts thoroughly adjusted, and even to diagnose the ordinary roadside troubles which are bound to occur.

From this it will be seen that it is almost essential for every motorist to know something of his car; and the purpose of this

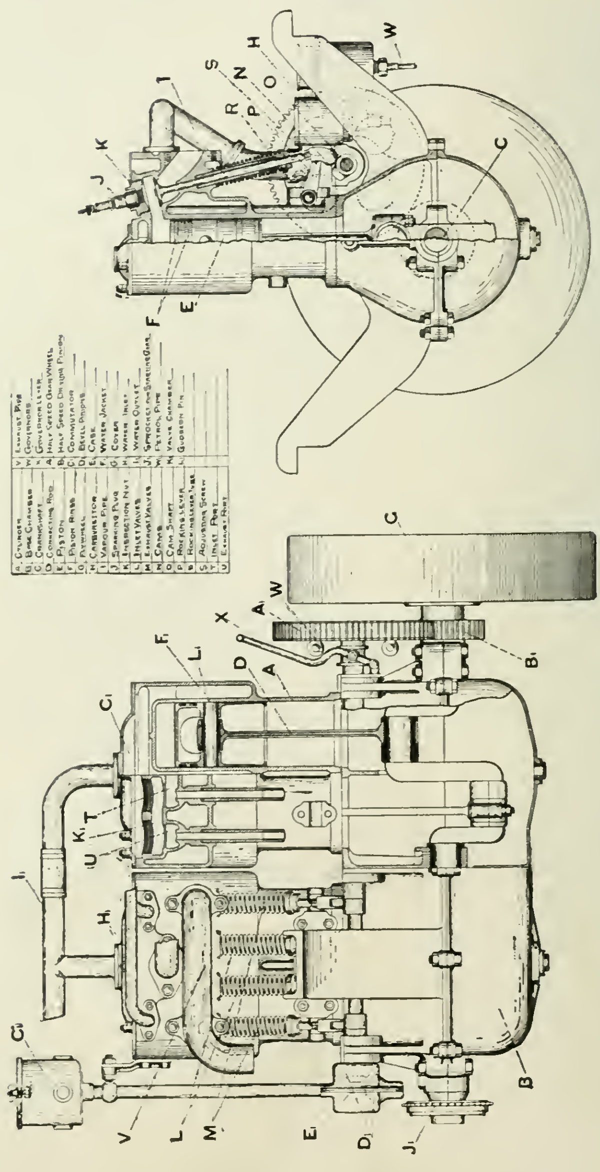


Fig. 1.—General arrangement of 18–22 h.-p. Daimler Motor. 1904 type

chapter is to give the novice a complete insight into the various parts of a petrol engine, and their respective functions.

What is a Petrol Engine?—'Petrol Engine' is a slang term for an engine driven by a series of explosions of a mixture of the vapour of a light spirit of petroleum with air.

'Gas engines' are similarly driven by explosions of a mixture of coal gas and air.

Both are known as 'internal combustion engines.'

In order to explain the system, there is here taken as an example a single-cylindered engine of the Daimler type.

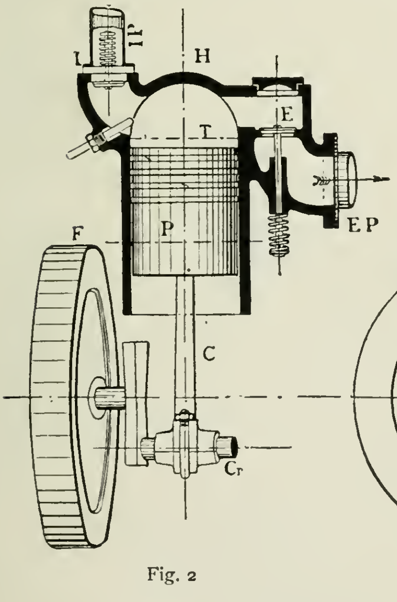


Fig. 2

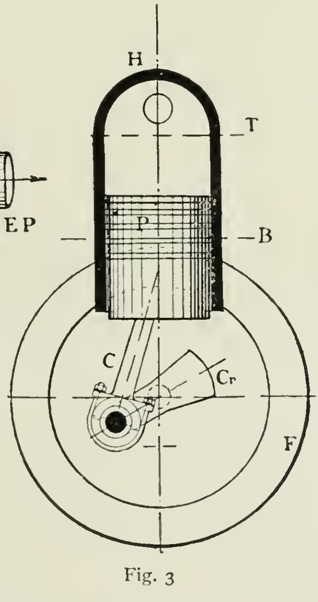


Fig. 3

Fig. 2 represents the section of such a motor if it be cut in half; fig. 3 the same motor cut in half the other way through.

P is a piston which accurately fits in a cylinder, and is free to pass up and down the interior of same. The top of the piston travels between the dotted line at the top, T, and the dotted line

at the bottom, B. The piston P is connected by the connecting rod C to the crank-pin Cr by means of which it turns the fly-wheel F.

Compared with the propulsion of the front wheel of the old high-wheeled bicycle, the connecting-rod C represents the rider's leg, the crank-pin Cr the pedal pin of the bicycle, and the fly-wheel F the large wheel of the bicycle.

The force which drives the piston downward, and so operates the fly-wheel F, is generated by the explosion of a mixture of gas and air in the space between T and H known as the combustion chamber. This mixture reaches the combustion chamber through the induction pipe I P, and the induction or inlet valve I. It is fired by an electric spark occurring in the combustion chamber, and the exploded charge is ejected through the exhaust valve E, as will be hereafter explained.

THE SUCTION STROKE

Let it be supposed that the fly-wheel has been set rapidly revolving, that the piston has been up at the top at T, and has just descended to the bottom of its stroke (B). In doing this it sucks down the valve I (called the inlet or induction valve), which is otherwise held closed by a spring, and thus draws through the valve from the induction pipe (I P) a mixture of vapour of petrol and air.

When the piston is at the bottom (B) the cylinder is fully charged with this explosive mixture.

The suction having stopped, the inlet valve is closed by its spring, and the cylinder is then air- or rather gas-tight.

THE COMPRESSION STROKE

The momentum of the fly-wheel then thrusts the piston up to the top (T) again, and in doing so, as there is no escape, the explosive mixture which had previously filled all the space in the cylinder between its head (H) and B is compressed into the very small space remaining between H and T.

This is what is known as compression. The explosive mixture has to be thus compressed before it is fired.

THE EXPLOSIVE STROKE

Just as the piston reaches the highest point (T) the explosive mixture is fired, either by means of an electric spark or in the case of the earlier types by a heated tube. The systems of firing are dealt with in the chapter on Ignition (Chapter VIII.).

It is sufficient at present to note that the highly compressed explosive mixture is fired, and as there is no outlet for the suddenly expanded gases (for the force of the explosion only tends to close tighter the inlet valve I and the outlet or exhaust valve F, which are referred to later), the whole force of the explosion goes to thrust down the piston from T to B. It is this thrust which gives the fly-wheel its momentum, its swing; it is this thrust, in fact, which makes the car move.

THE EXHAUST STROKE

At this point, when the piston is down at the bottom, at B, another valve, the exhaust valve (E), is opened (by an arrangement which is explained hereafter), and is kept open during the whole of this up-stroke from B to T, the consequence being that the exploded mixture is thrust out through this exhaust valve, which closes immediately the piston gets to the top again (T).

A COMPLETE CYCLE

This is the whole operation :—

Fig. 4, Diagram A.—A spot is shown upon the fly-wheel before the beginning of the operation.

Fig. 4, Diagram B, shows that during the suction stroke the fly-wheel has made half a revolution.

Fig. 4, Diagram C, shows that during the compression stroke a further half-revolution is made and the spot has returned to its starting-point.

Fig. 4, Diagram D, shows that during the explosive stroke a further half-revolution of the fly-wheel is made.

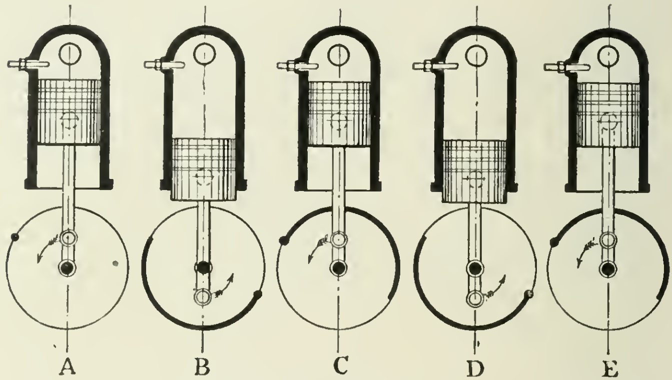


Fig. 4.—A complete Cycle.

Suction. Compression. Explosion. Exhaust.

Fig. 4, Diagram E, shows that during the exhaust stroke a fourth half-revolution is made. So for every explosion there are two complete revolutions of the fly-wheel.

INDUCTION VALVES

In Fig. 2 it will be seen that the interior of the cylinder is separated from the induction pipe I P by an inlet valve marked I.

Fig. 5 (a) shows the induction valve in its place in the wall of the cylinder, and closed so that no mixture can pass.

Fig. 5 (b) shows a section of the induction valve when the valve is open leaving a free passage for the mixture in the direction of the arrows.

The spring above the valve is of such a strength that it keeps the valve closed, except when the power of suction is exerted, when it opens and the explosive mixture is admitted from the induction pipe through the aperture thus made.

EXHAUST VALVE

In Fig. 2 it will be noted that the exploded gases are expelled by the rising piston from the cylinder through the exhaust valve E and exhaust pipe E P.

Fig. 6 (a) shows the exhaust valve in its position in the wall of the cylinder and closed against the escape of the exhaust gases.

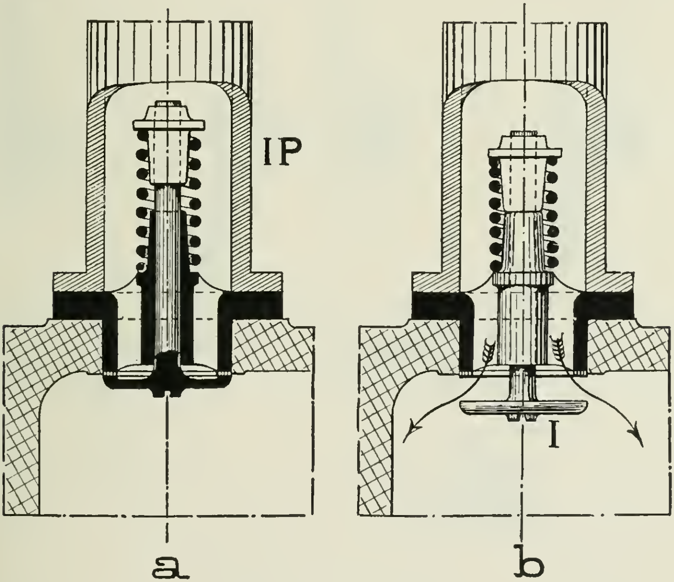


Fig. 5.—Induction Valve

Fig. 6 (b) shows a section of the valve when it is open, leaving a free escape for the exhaust gases in the direction of the arrow.

It will be noted that the valve is kept on its seat by means of a spring, and it remains in this position throughout the suction, compression and explosion strokes. During the exhaust stroke, however, when the explosive gases are expelled from

the cylinder through the exhaust valve chamber into the exhaust pipe, the exhaust valve is held open by a mechanical contrivance.

THE MECHANICAL LIFT OF THE EXHAUST VALVE

The simplest form of exhaust-valve mechanism is to be found in engines of the De Dion type, as illustrated in fig. 7.

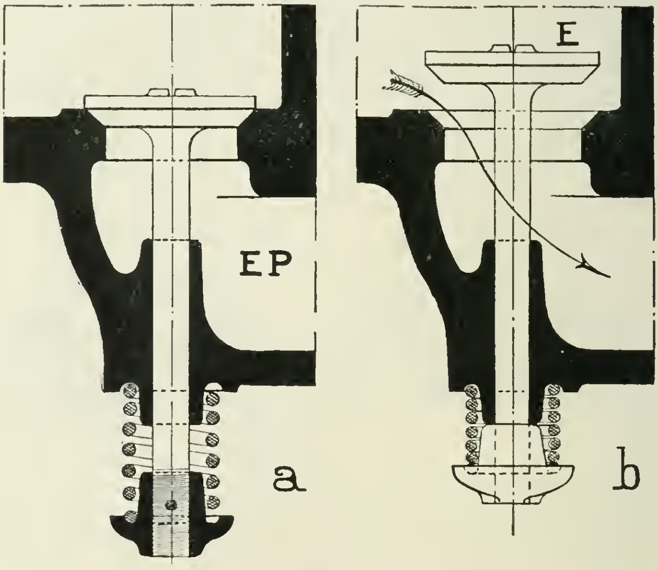


Fig. 6.—Exhaust Valve

A is the end of the crank shaft (fly-wheel shaft) on to which the small gear wheel B is fixed. This wheel engages with another wheel C, which revolves on the shaft D. The gear wheel C is double the size of B, consequently C revolves only once for every two revolutions of the crank shaft. In the solid with wheel C is mounted a cam E, which raises the exhaust valve H against the pressure of the spiral spring G, thus allowing the exploded gases to escape from the cylinder. The mode of working

is very simple. When the cam E revolves so that the projecting part comes on top, it pushes up the plunger J. J in turn pushes the spindle F, which carries on its top the exhaust valve H, and the latter is consequently removed off its seating, and permits the exhaust gases to escape. As E continues to revolve the protruding portion sinks from under J and the spring G pushes the exhaust valve H to its position on its seating. Needless to say, the gear wheels B and C must be so set that the cam E will open the exhaust valve H at exactly the right moment.

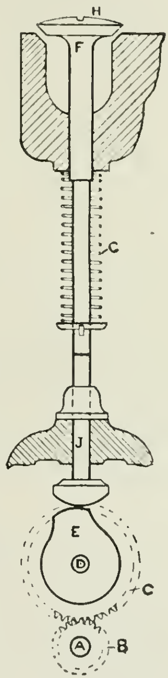


Fig. 7.—Exhaust Valve Lifter

The action of the exhaust valves in the two cylinder engines of the Daimler type is described further on under the heading Governors. The principle is exactly the same.

THE CARBURETTER

The Carburetter is the title given to the apparatus or vessel used to apportion the relative quantities of petrol vapour with air in the first instance, and their subsequent enrichment by the addition of further air in greater or lesser quantities according to the speed required from the engine and consequent greater or lesser intensity of the explosion given. Taking petrol spirit as the basis of a motor's power with a density of ·680 at a temperature of 60° F., if a volume of this vapour be diluted or mixed with some eight to ten volumes of air an illuminating but not explosive gas is obtained; but if a further addition of some ten more volumes of air be made, giving a total of some 19 parts air to one of petrol gas, an explosive mixture is the product. It is for this three-fold purpose that the carburetter is provided, and the cycle of its operation is thus comprised: (1) the petrol is introduced (we do not here discuss the method

of doing this); (2) it is vapourised and diluted with air which may be said to flow in simultaneously with the introduction of the petrol; and (3) it is rendered an explosive agent by a second addition of pure air to the already existing mixture. To attain these ends four methods are still in vogue, and these will be dealt with in turn. The first is a simple one called

(1) THE SURFACE CARBURETTER

This class, though gradually becoming obsolete, has the advantage that it is simple and effective, giving a wide range of possible elasticity to the motor's impulses, but from the fact that the petrol is exposed in a comparatively large quantity at a time to the atmospheric influence, it is wasteful and often necessitates the withdrawal from the carburetter of even a large amount which has lost its volatility or power of vapourisation.

The principle of its working is illustrated by comparing such a carburetter with a vessel almost closed at the top, but with a pipe inserted to within a third of the bottom, and a similar but larger pipe leading from the top to the engine. The spirit is permitted to run into the vessel up to and almost level with the bottom of the smaller tube. The larger pipe which leads to the motor is intercepted by a double or compound tap, commonly called a twin valve or tap, so made as to provide an air ingress but no egress. Its function is to provide the third necessary constituent to produce explosive gas, and this is done automatically by the aspirations or suction effects of the piston as it descends the wall of the cylinder. When the piston moves in this way, it produces a vacuum behind it, with the immediate result that a column of air is drawn down the smaller tube and wafted over the surface of the latent petrol, and thence rises to the larger pipe, when, according to the amount of opening given to the independent or pure air inlet, the volume is further increased and finds its way to the cylinder head, past the inlet valve and into the combustion chamber itself, its quantity being only determined by the

capacity of the cylinder space on the one hand and the duration of the period the inlet valve remains open on the other.

(2) THE WICK TYPE CARBURETTER

The features of this pattern consist in the employment of a wick formed of soft cotton which effects its purpose by what is termed capillary attraction—a process akin to the action of the common lamp wick when burning. The efficiency of this class of carburetter is largely dependent on the amount of surface that is exposed to the currents of air which pass through the pores. The Lanchester engine is fed by a carburetter of this pattern, and successfully gets over by capillary attraction the chief difficulty, that of waste, which is inseparable from the ordinary surface type previously described. The base of this carburetter is partially filled with petrol spirit automatically maintained at a common level, and above which is suspended the large surface of cotton wick in multiple strands. The suction of the motor, as before described, induces an inrush of air to the upper portion of the wick where the petrol vapour is hovering, carburetting it and so passing it on for further air treatment before it reaches the cylinders.

(3) THE SPRAY OR ATOMISING CARBURETTER

This is now the almost universally fitted type on all motors irrespective of size or number of cylinders. The chief points claimed for the spray carburetter are, its light weight and small size, its uniformity of results in general terms (we will allude to the improvements recently made to render it absolutely efficient later on), and its freedom from waste or residuary deposit. The general working of this type can be briefly explained by a reference to one of the best known specimens extant, the Longuemare, an illustration of which is here submitted.

Upon referring to the block it will be noted there are

apparently two chambers coupled together by a small trunk, the one on the left being marked A, which is the float chamber;

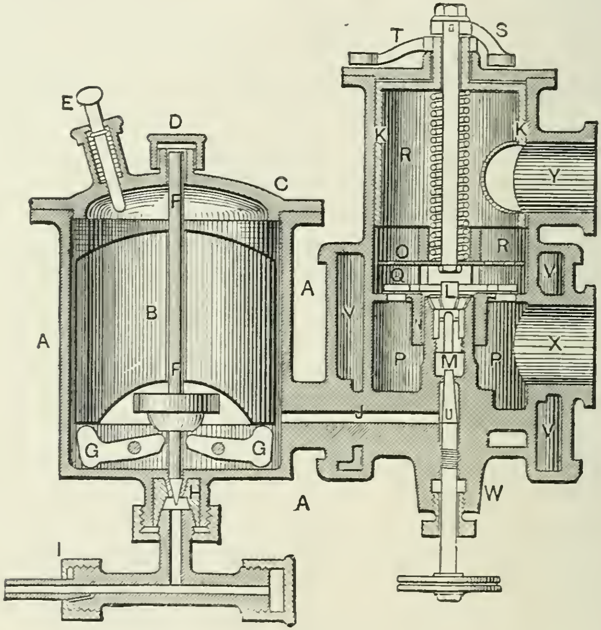


Fig. 8.—The Longuemare Carburetter

A A A, Float Chamber; B, Air-tight Copper Float; D, Cap to protect Needle Valve Spindle; E, Spring Piston for agitating Float; F, Needle Valve Spindle; G G, Float Balance Levers; H, Coned Joint containing Filter; I, Petrol Supply Pipe; J, Passage from Float Chamber to Carburetter for Petrol; K, Revolving Lantern for adjusting supply of Gas to Motor; L, Spraying Chimney or Nipple; M, Spirit Chamber below Nipple; N, Light Metal Tube constituting Air Passage past the Nipple; O, Perforated Baffle Plate for purposes of mixing; P P, Carburetter Chamber, with segmentally divided partition; Q, Revolving Plate, regulating auxiliary air supply through the partition from P, actuated from air lever S, and held in contact with the partition by the spring seen coiled about the spindle; R R R, Mixing Chamber where the vapour and air form a homogeneous mixture; S, Air Regulating Lever; T, Throttle, or gas-regulating lever; U, Needle Valve regulating supply of spirit to the chamber M; V, Exhaust Jacket around vapourising chamber; W, Stuffing Box around needle valve spindle; X, Warmed Air Pipe entering carburetter; Y, Connection to Induction Pipe of Motor

B is the float itself, and consists of a hollow air tight and light spun brass vessel, while D is a cap to protect the needle valve spindle F, which is guided by a small circular hole in the float chamber cover. E is a small plunger mounted on a spring in the cover, its object being to depress at the will of the operator the float B to ensure the latter acting freely or to assist in getting the engine to start easily by flooding the carburetter and so ensuring a sufficiently rich mixture. F is the needle valve spindle, with a collar to balance the weight of the float itself. The small levers G G are two supporting levers for both float and spindle, and so pivoted as to provide a sensitive adjustment for the control of the petrol to the chamber A. H is a coned joint with a gauze filter attached, while I is the petrol elbow pipe leading to the needle valve point, with a detachable end-cap for cleansing purposes.

The action of the carburetter is explained thus: the petrol flows into the chamber A until the volume admitted raises the float B and thus depresses the needle valve F. This automatically closes the orifice at H. The petrol is then drawn along the pipe J to the base of the cone U, whence it is sprayed from the chamber M by means of the spray chimney L. As the petrol is sucked up by the engine the float B sinks, which opens the valve V, and a constant level in the float chamber is thus maintained at a fraction of an inch below the aperture of the nipple, and consequently only a small suction is required to lift the spirit before it issues from the orifice. This also ensures only the right amount of petrol finding its way to the sprayer or nipple L, being dependent on the suction effect of the piston itself, and is a partial explanation of the comparative economy of this type of carburetter. The chimney L is a closed brass tube with a collar-like cone, which has a number of fine notches cut longitudinally on it. These, when the collar is bedded with the corresponding seat, form very fine passages for the petrol spirit and so constitute the sprayer. N is the tube which restricts the passage of the air past the nipple to cause the suction of the petrol, and is suspended from a brass plate,

which forms a partition in the hollow chamber P P, and has segments cut out, corresponding with similar devices in the auxiliary air inlet disc Q. The effect produced is that any motion of Q in a circular direction can be followed by adjustment of the lever S which controls the area of the openings. The perforated plate O to be seen directly above this adjustable partition catches the pure air and the rich vapour from P and N respectively, and by baffling their passage produces a perfect mixture of the two before it passes to the gas chamber R, whence it enters the induction pipe of the motor through the aperture Y, where the flow is adjusted by the lever T by means of a revolving lantern-sleeve K within the chamber R. X is the air passage, whence the incoming air, rushing up past the nipple L, is carburetted, thence is led through the plates P and Q to be further charged with pure air, afterwards past the baffle O to the throttle valve, and thence to the motor. To assist the due vapourisation of the spirit a small pipe is led from the exhaust pipe of the motor and conveys a constant current of the hot gases round the jacketed body V.

The Automatic or Extra Air Valve.—In connection with all carburetters great difficulty has been experienced in ensuring a perfect mixture at all engine speeds. Let us suppose that a carburetter is correctly designed or proportioned to supply a perfect volume of explosive gas at a given speed of, say, 1,000 revolutions of the engine. In theory this might be expected to give a constant proportion varying in quantity, but not in quality, at the diminished rate of the piston speed of the engine. This it does not do; because as the speed of the engine drops the air is naturally more easily affected by the diminished suction than the petrol, and the mixture therefore becomes weaker and weaker as the engine slows until at last it reaches a point where it becomes non-explosive. To secure a correct mixture at all speeds and so render the running of a motor at as low a number of revolutions as 200 per minute, with the many advantages that this greater flexibility or elasticity gives, has been the object of some of

the foremost motor designers of the day. Herr Mayback in Germany, M. M. Krebs, Leon Bollée, and Henri Walcker in France, and the Napier and Crossley firms in England, not to mention many other clever motor engineers, have put forth their best efforts to effect this two-fold purpose, and their experiences have been embodied in the modern petrol

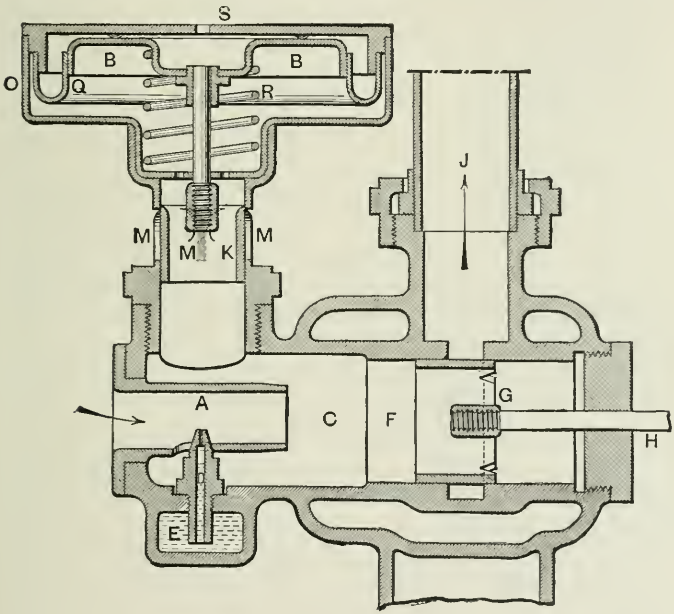


Fig. 9
The Krebs Carburetter

motor which has entered on a new era of its history. The outcome of their experiments may be said to be comprised under three headings: (1) automatically controlled, varying air intake depending on the varying speed of the motor itself; (2) a similar device actuated more or less by mechanical means through the medium of a mercury-filled float chamber; and (3) by means of a mechanical control effected hydraulically

by a positive acting pressure, which operates on an automatic auxiliary air valve. Of these several designs, those of Mayback, Krebs, Bollée, and Walcker are illustrations of the first, the Crossley of the second, and the Napier of the third types.

The Krebs Carburetter.—To Commandant Krebs, the managing director of Panhard and Levassor, is generally attributed the honour of first devising an automatically operated air valve with an action entirely synchronous with the pulsations of the engine. It was designed to give a perfect mixture at as low a speed as 200 revolutions per minute of the motor, with the auxiliary air supply coming into operation at 300 revolutions. The sectional drawing will with the aid of a key readily explain itself. J is the inlet pipe to the motor, while C is the carburetting chamber which communicates with it, but is closed by the piston F which in turn is controlled by the rod H; A is the constant air-inlet passage communicating with C, and through which the air flows from A, passing on its way over the jet D, whence the petrol is sprayed from a tube E. When the speed of the motor increases beyond 300 revolutions the auxiliary air supply through the inlet M comes into operation, but below that speed these inlet ports are kept closed by the piston valve K. The chamber O contains a diaphragm valve (merely a metal plate with a rubber cushion or sleeve connected to the cover of the chamber). The spring R controls its action, keeping it pressed against the cover until the speed increases beyond 300 revolutions, when as the suction power of the motor increases the spring resistance of R is overcome and the diaphragm is drawn down, in turn opening the valve K and so admitting additional air. To prevent an irregular or undulating motion of the diaphragm a hole is drilled at S through the top of the cover, and so provides an air cushion of atmospheric pressure (14·9) to the square inch. By this arrangement the pure air supply is exactly proportioned to ensure a correct mixture to suit all engine speeds.

The Chenard and Walcker arrangement.—M. Walcker claims for his carburetter that the suction is practically constant and entirely automatic, a result obtained from the perfect and unfluctuating vacuum he gets. He explains this by reference to the spring F, which has a tension common to all the grades of the valve C's opening. A reference to the diagram will explain the working of this carburetter. On turning the motor the suction operating through the inlet pipe G effects the spring-controlled needle valve D, causing the latter to lift from its seat and to permit a small quantity of petrol to enter the mixing chamber. The air inlet is at A, but with the controlling valve at C, while B B are annular air passages closed by the valve C. The air inlet port is closed by a flat seated valve, the petrol inlet being mechanically closed by a central conical needle valve, with the needle forming an integral part of the valve and lifting with it. Thus every movement of the air valve C is followed by a proportional lifting of the needle valve D, the relation of the air and petrol openings being always constant. The valve is always endeavouring to remain closed under pressure of the spring F, and in order to prevent this it is obvious the suction must be enough to overcome the tension of this spring. As the speed of the motor increases, the valves lift more and are similarly reduced when the revolutions decrease, hence the relations between the air and needle valves and the motor remain constant, varying only in relative proportions, opening

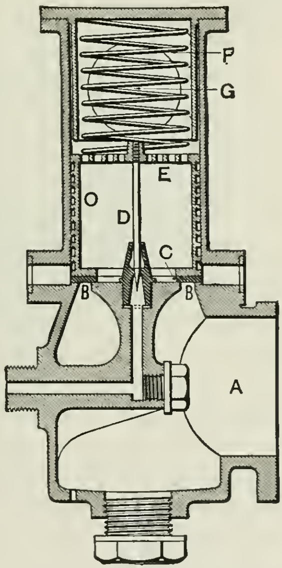


Fig. 10
The Chenard and Walcker Carburetter

simultaneously with the suction stroke of the engine, and closing promptly at its close. So flexible are the results obtained that, aided by the mechanically operated inlet valves with variable lifts, the Chenard and Walcker car is capable of speed adjustments ranging between top speed and two or three miles per hour, the control being effected solely by the increase or otherwise of the amount of the inlet valves lift, and without any reference to the carburetter, which is entirely automatic in action.

The Crossley Carburetter.—The previous type of carburetter may be described as a species of automatic mechanism depending largely for its efficiency on the correct tensioning of the controlling spring or diaphragm valve as the case may be. The Crossley carburetter depends for its automatically controlled air supply on the influence exerted by the vacuum acting on a body of mercury, which as it expands or contracts in turn influences the auxiliary air supply. It is essentially automatic and does not depend on a mechanical adjustment for its efficient working, it being simply a practical illustration of a well-known natural law. The construction will be readily grasped by careful reference to the two views of the apparatus with the aid of the subjoined keys. The petrol enters the chamber H (fig. 11) from the pipe H 1, where a constant level is maintained by the usual balanced float and needle valve. It passes on to a jet which projects into the mixing chamber J, which is divided into two compartments by a cone. Air enters the chamber J through the gauze-covered hold J 1; a cover J 2 (fig. 12) is bolted on to the end of the chamber, the chamber J being water-jacketed, one of the connecting pipes being shown at J 5. The air after passing through the cone is drawn through a passage to the induction pipe, but is interrupted by a throttle valve. The petrol jet (not shown) projects into the cone, while a needle valve is mounted just above it for regulating its effective size. Another nozzle H 4 (fig. 12) also projects through the side of the cone, close to the sprayer, and passes to the outside of the casting

J, where it terminates in the fitting H 5. The air entering at J 1 (fig. 12) sweeps through the above cone, drawing in petrol through the jet H 2 (fig. 12), with a similar action on jet H 4 (fig. 12). This latter jet is connected by a pipe (not shown) to the union H 6 (fig. 11). This fitting leads into the base of the casting K (fig. 11), which is screwed into the flanged cover

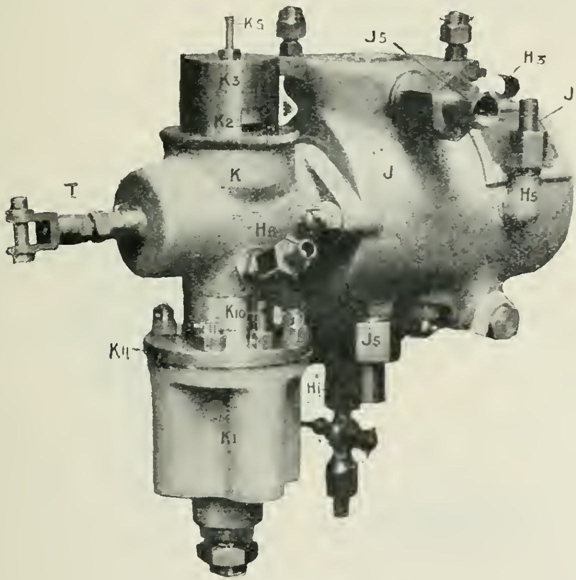


Fig. 11

Rear view of the Crossley Automatic Carburetter, showing the water-jacketed mixing chamber, auxiliary air-valve, throttle valve, and mercury chamber

plate K 2 of the mercury chamber K 1 (fig. 11), which in turn fits closely to the top of a sleeve (not shown) forming a partition inside the chamber K 1. This sleeve has a wood plug inside it at the bottom, and its lower edge is slotted so as to render the interior of the sleeve in open communication with its exterior at the base of the chamber K 1. The plug has a hole drilled through its centre, through which the

mercury passes, and also acts as a guide for a spindle carrying a wood float, while at its upper end it supports a piston valve inside the cap K 3 (fig. 11). The chamber K 1 (fig. 11) is filled with mercury to a determined height, which under ordinary circumstances has a constant level. Above its level, however, there is no open communication, and the space immediately above the float is connected with the jet H 4

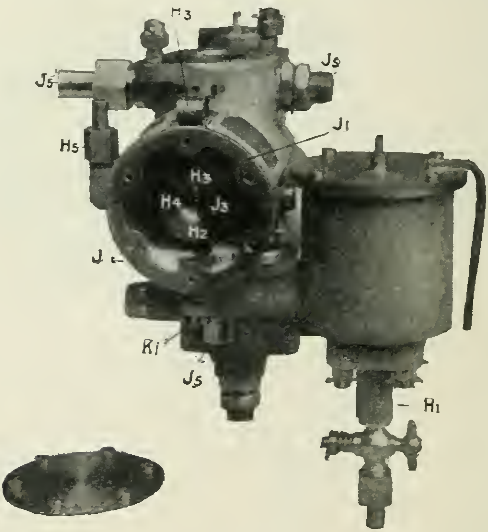


Fig. 12

End view of the Crossley Automatic Carburetter, with cover plate J 2 removed to show the induction cone J 3, spray jet H 2, needle valve H 3, and the suction jet H 4

(fig. 12), while the space outside the partition is in open communication, through a vent hole K 10 (fig. 11), with the atmosphere. Inside the sleeve (not shown) on K 1 (fig. 11) the wood float rests upon the surface of the mercury, while outside, four steel balls rest upon it to prevent splashing. The level of the mercury inside the sleeve depends of course upon the degree of suction on the jet H 4 (fig. 12), so that the

fluctuations in the mercury level are followed by similar movements on the part of the auxiliary air valve which is thus

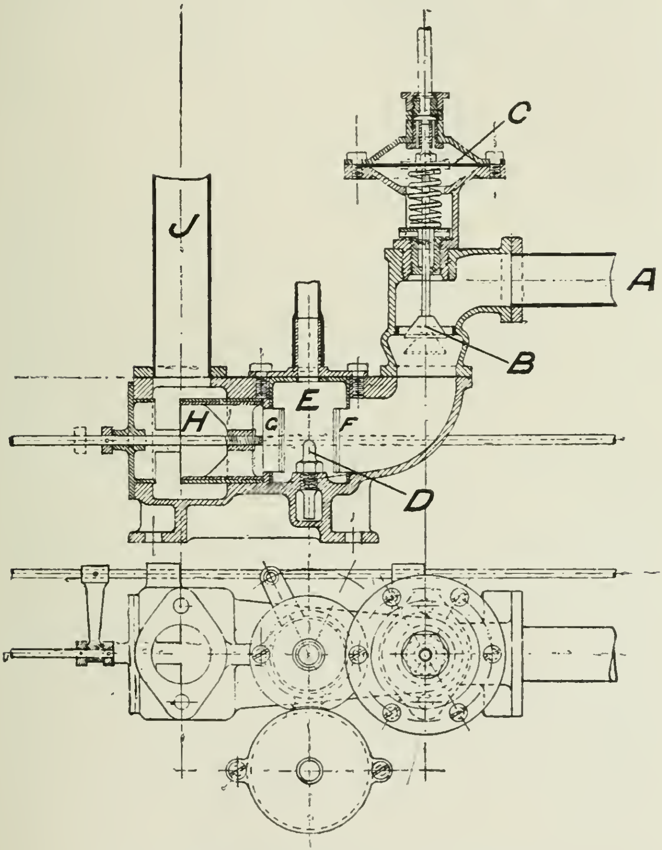


Fig. 13.—The Napier Hydraulic Air Regulator
(From 'The Motor News')

automatically effected and governed. The power and speed of the motor are controlled by the throttle valve, whose lever is shown at T (fig. 11), in the ordinary way by the

driver, either directly or by an automatic governor in conjunction with the usual accelerator pedal.

The Napier Carburetter.—The third type of carburetter fitted with an automatically controlled auxiliary air valve is the ingenious production of another British concern, the Napier Company, and effects its purpose by the utilisation of the ordinary forced water circulation system common to most types of cars, or in other words it achieves its purpose by hydraulic power. On reference to the drawing it will be noticed that A is the air intake, B a throttle valve controlled by the diaphragm C; D is the ordinary petrol jet; E is a hollow circular valve surrounding the jet, and has two ports, one, F, controlling the air admission to the jet chamber, the other, G, acting as a throttle on the mixture. H is the ordinary governor-controlled throttle valve, while J is the vapour pipe to the motor. To obtain the correct mixture at all ranges of motor speed is effected by means of a hand-controlled throttle E, which in operating involves a double movement; thus as it is rotated the gas port G and the air port F are synchronously affected, there also existing a varying shape and size between these ports which establishes a permanent ratio between the flow of gas and air. The auxiliary air valve which comes into operation with the increased speed of the motor is controlled by the medium of the diaphragm valve C which works through the action of the ordinary water circulation pump. When the motor is at rest the valve C is on its seat at B held by the tension of a spring, but when it is started, and the pump begins to circulate the water, a pressure is at once exerted on the face of the diaphragm. As this increases with the speed of the engine, the resisting power of the spring is gradually overcome until it is depressed from its seat and admits an increased quantity of air to the carburetter. As the driver operates the throttle H so is the quantity of mixture to the motor lessened or increased, followed by variation in the speed, with a corresponding alteration in the pressure of water at the diaphragm head.

Hence, it follows that when maximum power is wanted, these three movements may be said to be effected simultaneously, but the sensitiveness of the auxiliary air valve insures a more delicate and automatically fluctuating movement and the more readily responds to the smallest variation in the motor's speed.

(4) THE POSITIVE FEED CARBURETTER

This is a type of carburetter used by a few makers, notably in the construction of the Gobron-Brillie motor. It is an arrangement by which the requisite amount of petrol is measured automatically for each stroke of the engine, either by a plunger-type pump, or a rotating ratchet-driven plug with small recesses or chambers cut into it to receive the measured liquid. The Gobron-Brillie, one of the best illustrations of this type of pulverising carburetter, was patented in 1898. It may be described as a measuring apparatus with a multiple bucket, held on its seating by a light spring, which, in turn, sits upon a little disc which is fixed to a small spindle. Spirit is fed to its entrance chamber, and finds its way round the larger part of the bucket, entering by means of an annular passage, exactly opposite which is the outlet. When the air and vapour admission valve admits a charge, the greater part of the former is drawn through a separate valve, but a small amount enters the petrol chambers and carries with it the measured quantity of petrol which is in the bucket into the vapour pipe. This carburetter, as fitted to the above motor, will work equally well with most other light spirits besides petrol, and notably with alcohol.

SYSTEM OF GOVERNING

To check the varying speeds of a motor, implied in the terms running 'light' or under 'load,' which, if not automatically governed by some mechanism operating on the source of the motor's energy, would soon tend to upset the correct working of the machine, to say nothing of the racking of the

working parts which an unrestrained speed would soon induce, is the object of the device termed a governor. Though the purpose of the governor is one common to all motors, its method of application differs, but its effect is the same and results in the reduction or acceleration of speed as required by reducing or increasing, as the case may be, the volume of vapour that, on firing, will give the impulse to the piston. The means by which this result is effected may be described under five headings.

(1) REDUCTION IN THE VOLUME OF FUEL

(A) By throttle valve in the inlet pipe, (B) by mechanically affecting the opening of the inlet valve, and (C) by reducing the time of its opening.

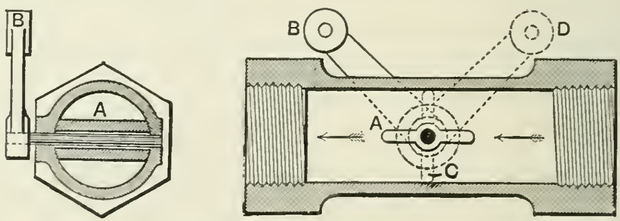


Fig. 14.—The Throttle Valve

The first of these methods (A) is one of the simplest known, and is merely the application of the old butterfly pattern valve so long in use on the steam engine. The method of its action may be readily understood by describing it as a means of blocking the area of the inlet pipe, by the use of an elliptic-shaped piece of metal plate which is attached to a spindle that passes transversely through the pipe. The edges of the plate are bevelled off sufficiently to ensure the pipe being closed when the valve is in one position, and at the same time to ensure its maximum opening when the plate is parallel with the axis of the pipe. By varying the movement of the valve, it is obvious that a greater or lesser amount of opening will be

provided, and within these limits the speed of the motor is governed.

To effect this control by automatic means a mechanical arrangement (fig. 15)—also borrowed from the steam engine—is adopted, and this is really the governor proper. It consists of a revolving spindle A, to which are affixed two or more spring-controlled arms Q Q, the latter being weighted by balls O O of suitable size for the rated speed to be provided. As the engine revolutions increase the centrifugal force exerted causes these arms to lift until they assume a position almost

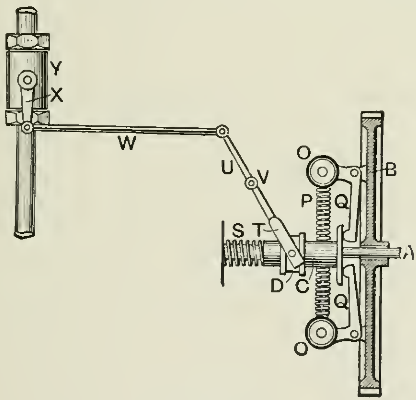


Fig. 15

rectangular with their normal one. Coincident with this movement it will be observed that the sleeve C is pushed forward by the levers Q Q as the speed of the engine increases; C in turn operates the fork T on the rod U, which is pivoted at V. The throttle lever X is connected to U by the rod W, and so regulates the amount to which the throttle valve opens or shuts, as the case may be; S is a spring which keeps the sleeve C in contact with the arms Q Q. The throttle valve is inside the chamber Y, and is situated either close to the carburetter or between the carburetter and the induction valve. The vapour ascends through the pipe, and consequently to

reach the combustion chamber must pass through the chamber in which this throttle valve is situated. The action of the governor is further illustrated under Governing by Retention of the Exhaust Gases.

For the purpose of checking the governor itself and ensuring the maximum speed of the motor when wanted, an accelerator, as it is termed, is provided, and controlled from some place convenient to the driver's foot or hand. It is a simple arrangement which merely prevents the effects of the governor's action being transmitted to the throttle valve.

On many small cars with single-cylinder engines, no automatic governing device is fitted ; hence, to prevent racing of the motor when the load is released, the driver has to effect this object by a hand-operated throttle lever or similar device.

The second means (B) of reducing the volume of fuel by mechanically affecting the opening of the inlet valve, is essentially one of the best at present known, and approximates more closely to the ideal arrangement than any other mechanical means yet adopted. The mode of its working is by varying the lift or opening of the inlet valve, by means of an alteration in the length of the cam that effects the mechanical opening of the valve. By tapering this cam from end to end, the amount of opening will vary with the relative position of both the cam and the operating valve rod at a given moment. Thus, if the longest part of the cam be under the latter, the amount of opening of the valve will be greater, and equally so will it be less under the corresponding short surface of the cam. Within these limits the amount of the opening of the inlet valve can be determined, and this is arranged by a sliding motion of the shaft which is coupled by means of a sleeve with the governor; thus, when an increase of speed takes place the cam shaft is moved in a sliding direction with a resulting reduction in the amount of opening permitted to the inlet valve. The chief reason for the high efficiency of this system of governor control is to be found in the fact that the ordinary centrifugal type of governor does not

follow a straight line law; thus, supposing the outward motion of the weights O O (fig. 15) against the action of the springs Q Q to be half an inch for an increase in speed of 100 revolutions, between, say, 300 and 400 revolutions, the motion for a similar acceleration between 1,000 and 1,100 might be but one-eighth inch, since both the angle of the balls about their fulcrum and the strength of the springs have altered. With the use of a sliding tapered cam subject to the governor's control, allowance can be made by decreasing the difference in diameter over the tapered surface to correct the above errors in governing, and so make the regulation of the valve itself more constant.

Governing by reducing the time of the opening of the inlet valve (C) is not largely used, but it somewhat resembles the cut-off action by the valve of a steam engine, and depends for its effect on a variable spring device in conjunction with a suction valve. There is one serious objection against this method: it not merely curtails the volume of gas in the cylinder, but it also reduces the compression pressure and therefore the explosion effectiveness also, which for economical running of the motor is quite wrong in practice.

(2) GOVERNING BY COMPLETE CUT OUT OF FUEL SUPPLY

This is the system of governing adopted on the Lanchester and Gobron-Brillie cars. The Lanchester method operates through an inertia governor, acting in conjunction with the patent valve gear; the Gobron-Brillie has a positive fuel feed by means of a rotating plug fitted with pockets which carry a measured quantity of petrol to the feed chamber as they revolve. In this case the governor holds the plug stationary when the speed rises beyond the limit to which the governor is set.

(3) GOVERNING BY RETENTION OF THE EXHAUST GASES

This is one of the oldest methods of governing in use, but is becoming obsolete. The Daimler motor was fitted with this

device and furnishes an apposite illustration of its application. Briefly put, it consists in temporarily preventing one or both exhaust valves from opening. Consequently the combustion chambers remain full of the spent gases, and no fresh charge can then be admitted until the motor decreases in speed and the exhaust tappet again comes into operation, causing the exhaust gases to be expelled. To understand the method of action of this form of governor, reference should be made to fig. 16, where cam E, which is fixed on the two-to-one gear shaft, bears against the roller L, which in turn lifts the arm K, when the projecting portion comes in contact with L. The step M then pushes against the digger J, which in turn lifts the stem of the exhaust valve by means of the plunger R and so opens the valve. The foot-shaped lever D 1 is called the hammer, and normally rests on a circular collar D 2, which is fixed on the half-time shaft. Alongside this collar there are two stepped cams, marked D 3 and D 4 (fig. 17), but which are not shown in fig. 16; hence, when the governor comes into operation through the high speed of the motor, the cam D 3 is pushed under the hammer D 1. This hammer forms a portion of the bracket H, and, therefore, when it is pushed downwards by cam D 3 it forces the link I forward, which in turn pushes the plunger R, causing the digger J to miss the step M, with the result that the exhaust valve does not open.

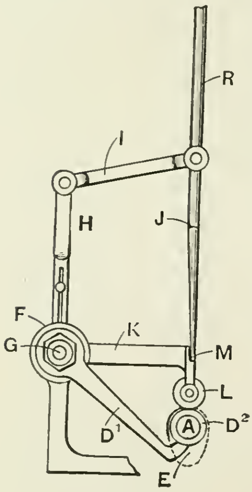


Fig. 16

The working of the governor will be readily grasped on reference to fig. 17, where B is a geared wheel attached to the half-speed shaft A consequently revolving with it, O O being governing weights attached to B, close to its circumference, while Q Q are arms, the ends of which touch the sleeve C,

which slides on the half-time shaft A. P is a spring between the weights O O, which offers a check on the tendency of the latter to fly outwards. As the pace of the motor increases, the centrifugal force developed overcomes the resistance of the spring P, the weights move outwards, and the arms Q Q press against the sleeve C which being free to slide on the shaft A enables the cams D 3 and D 4 to come in turn under the

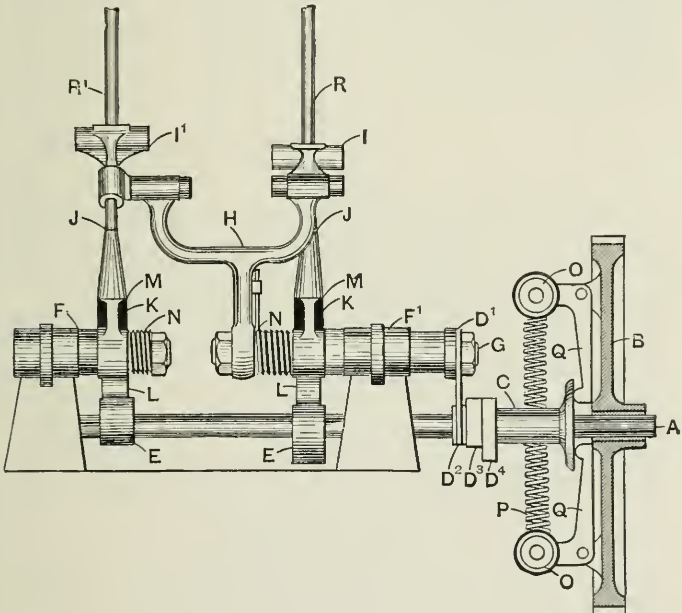


Fig. 17

hammer D 1. Now the bracket H and the hammer D 1 are parts of the shaft G, thus, when the hammer is pushed outward by the projecting portion of the cam D 3, the bracket H is pushed forward, and, in turn, pushes forward the plunger R and with it the digger J, as before described. As regards the second cylinder, it will be noticed that the link I^1 is free to slide in a guide on the left arm of the bracket. Consequently,

when the hammer rests on cam D 3 and the bracket H is pushed forward, I^1 slides in the guide and the spindle R^1 is not pushed forward. When, however, the hammer rests on cam D 4, the bracket H is pushed forward still further, and a stop on I^1 comes against the sides of the guide, so that R^1 is pushed forward and the second exhaust valve cuts out as well as the first. Needless to say, the exact speed at which one or both cylinders cut out is regulated by the setting of the governor. The construction of the governor proper is the same as is illustrated in fig. 15.

(4) GOVERNING BY RETENTION OF PART OF THE EXHAUST GASES

This is essentially the De Dion system of governing, but is also used on some other motors. The lift of the exhaust valve is varied so as to retain a portion of the exhaust gas in the cylinder, the result being that a smaller quantity of mixture is drawn into the cylinder, while at the same time the compression remains normal. By its use, the speed of the car can be controlled with great certainty, and the noise of the exhaust considerably reduced when the motor is running 'light.' It can be operated either by a hand lever fixed on the steering column, or for varying use—for example in traffic—by means of a pedal operator.

On reference to fig. 18 the method may be readily gathered. The cam E acts on a rod B pivoted eccentrically on a rocker A, which is moved by a lever controlled either by the hand lever on the steering column, or a pedal. In its normal position the eccentric is so placed that the rod B is at its highest point, and thus at each stroke of the cam the exhaust valve is opened to the fullest point. If the rocker A is revolved from right to left, the rod B is pushed forward, so that the cam E reaches D at a later point in its revolution, thus a lesser lift is given to the plunger F, and according to the amount of motion given to A, the lift of the exhaust valve is regulated.

(5) GOVERNING BY RETARDING THE SPARK

This is a simple method of governing that is now practically confined to the control of motor cycles and small cars only. To understand its working it is but necessary to remember that if the full force of the explosion occurs in the combustion chamber at the moment when the piston is at the highest point its effect will be greatest, for the compression at this point is essentially the highest attained. But this will be reduced as the piston starts to descend in the cylinder, and if the firing of

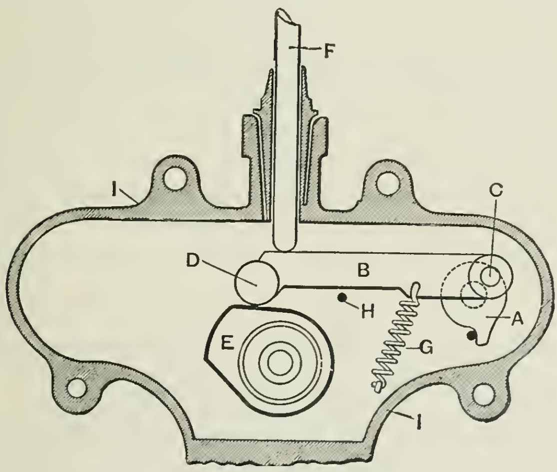


Fig. 18.—Exhaust Valve Regulator

the charge be delayed it will affect—according to the measure of the expansion the charge has already undergone—the potency of the explosion. This is obtained by varying the firing period by means of a suitable device which is so arranged that the automatically controlled means of effecting the firing is altered to produce the desired result. In other words, the moment of completing the electrical circuit followed by its rapid breaking is so altered that the spark takes place at varying points, but relative to the speed the motor is to be run at.

Though essentially a simple method, it depends for its application on the will of the driver, and cannot therefore be considered of itself an automatic means of control. It has the disadvantage, when used to produce a late firing of the charge, that the gases when fired are still in a state of active combustion when the exhaust valve is opened for their expulsion ; hence it will result in ultimately burning the latter and will probably foul the cylinder and valve area, besides entailing a considerable waste in fuel and undue heating of the engine.

SILENCER

The exhaust pipe from the engine which conducts off the exhaust gases after they have done their work in the cylinder is connected to a peculiarly constructed chamber, called a Silencer, attached to the frame of the car. The object of the silencer is to deaden the noise of the escaping gases by :—

1. Breaking up the body of gas into a number of fine streams.
2. Allowing the gases to expand and cool.
3. Checking the velocity without putting back pressure on the engine.
4. Reducing the pressure of the gases till they are as nearly as possible the same as the atmosphere.

To do this, the chamber is divided up into a series of compartments, and the gases in their passage from one to the other have to pass through baffle plates drilled with a number of fine holes, the combined area of which must be considerably in excess of the area of the exhaust pipe, to allow of a free passage for the expanding gases. The flow is thus broken up and subdivided into a number of fine streams of cool gas at or near atmospheric pressure, which cause little or no noise on their escape into the air. It is the sudden expansion of the gases at a high pressure which causes the noise.

Figs. 19 and 20 depict two types of silencer which are very largely used. Fig. 19 shows a sectional view of a silencer composed of three concentric cylinders, A, B, and C. A is com-

posed of a tube or inverted cylinder of sheet steel; B is the second tube similarly constructed; while C is an extension of the exhaust pipe from the engine. Two chambers, D and E, are thus formed. The exhaust gases from the engine enter C,

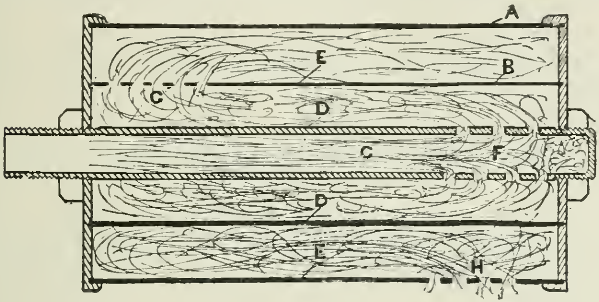


Fig. 19.--Silencer

and passing through a number of holes at the end of the pipe at F, expand in the chamber D. Passing from the chamber D through the holes at G, the gases enter the chamber E, where a further expansion takes place. Finally the exhaust is ejected

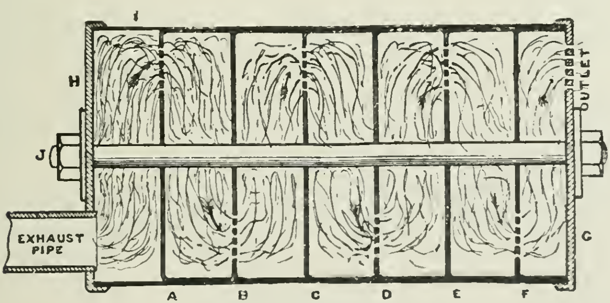


Fig. 20.—Silencer

to the atmosphere through the holes at H. The construction of the silencer can easily be followed from the illustration.

Fig. 20 depicts the second type of silencer, which almost explains itself. I is a cylindrical steel body fixed to the end

plates G and H. This body contains the baffle plates A, B, C, D, E, and F. The exhaust gases are seen entering the silencer through the exhaust pipe. The direction which they take through the baffle plates is shown by the arrows, and it will be seen that the pressure is reduced in each succeeding compartment in the cylinder. The bolt J, passing through the centre, serves to hold the silencer together and to resist the pressure of the gases.

MOTORS WITH MORE THAN ONE CYLINDER

When it is remembered that the oil motor constructed on the Otto cycle system receives only one impulse stroke for every two complete cycles or revolutions of the crank shaft, it can easily be seen how unsteadily such an engine will run unless some attempt is made to balance not merely the reciprocating parts, but to absorb some of the heavy thrust that such a direct impulse will convey. This is effected in the case of the single-cylinder motor by a heavy flywheel, so built, that by means of a suitable distribution of metal in its construction the moving parts are counterbalanced, and some portion of the direct thrust is absorbed in the periphery of the balance wheel, a sort of stored energy to be liberated as the effect of the impulse becomes lessened and during the idle portion of the succeeding revolution. Still further to reduce this period of idleness, and to get a more constant result, a two-cylinder engine is used. In this type of motor the placing of the second crank in its relationship to the first may be done in two forms. (1) It may be placed at an angle of 180 degrees from the other, that is to say, the piston it controls will be exactly at the bottom of the cylinder when the other is at the top; or (2) this crank may be placed in the same line as the first and then both pistons will descend their respective cylinders together.

No. 1 *Method. Cranks at* 180 *degrees apart.*—To illustrate the cycle of operations attending this arrangement we

will suppose that a movement by hand has been given to the engine—such as is customary when starting up a twin-cylinder motor—and that both cylinders are filled with the combustible mixture; at the firing moment the cycle will be as follows in each cylinder respectively:—

First Cylinder		Second Cylinder	
Firing, Exhaust	First revolution of crank shaft.	Compression, Firing	First revolution of crank shaft.
Suction, Compression	Second revolution of crank shaft.	Exhaust, Suction	Second revolution of crank shaft.

Thus it will be seen that in the first revolution of the crank shaft two impulses are given—one to either piston, but on the second no firing moment is provided; while on the beginning of the third revolution the firing is again resumed in No. 1, followed at a half period of the revolution by a firing period in No. 2.

No. 2 *Method. Cranks on the same line.*—In this arrangement both pistons work simultaneously in the one direction; but the suction and exhaust movements are opposed. The action is as follows—presuming No. 1 cylinder to be already filled with compressed gas:—

First Cylinder		Second Cylinder	
Firing, Exhaust	First revolution of crank shaft.	Suction, Compression	First revolution of crank shaft.
Suction, Compression	Second revolution of crank shaft.	Firing, Exhaust	Second revolution of crank shaft.

It will be observed that by this disposition of the cranks an impulse is given at each revolution of the crank shaft. It is only necessary to add that while in the first arrangement—or with the crank set at an angle of 180 degrees apart—the reciprocating parts are better balanced by their opposing movements, the fly-wheel must be correspondingly larger to

ensure the necessary momentum to run the motor during the idle or non-firing revolution and to overcome the resisting strain of the compression period of the stroke. With the cranks set in the second fashion, the firing periods being regular, there is only the balancing of the reciprocating parts to be considered, but this is by no means an easy task, when it is remembered that though relatively their movements are alike, the strain periods are intermittent and therefore tend to disturb the balance of the parts.

THREE-CYLINDER MOTORS

The above may be considered as a means to overcome the obvious limitations of the two-cylinder type on the one hand, and to provide a more flexible and better balanced motor on the other, without the aid of a fourth set of mechanical parts. The cranks are usually set at 120 degrees apart, though in one design they are set two in line with the third at 180 degrees to them. That some of the best makers are satisfied with the arrangement, which certainly must make for reduction of vibration, it may be mentioned that Messrs. Panhard & Levassor, Brooke, the Duryea Co., the Ariel Co., Messrs. Maudslay, and the makers of the Argyll car, are fitting this type of motor to their productions. The effect is to give an impulse at every two-thirds of a revolution of the crank shaft.

Four-cylinder Motors.—With the disposition of the cranks at 180 degrees each to its relative firing neighbour two impulses for every revolution of the crank shaft are provided, with the gain of an increased steadiness, and consequently less vibration throughout the machine. The effect may be compared to the working of an ordinary double acting reciprocating steam engine with two cylinders, the four-cylinder petrol motor having only one impulse movement per cylinder, consequently the necessity of providing two others to complete the full cycle of a fourfold explosion per revolution of the crank shaft.

Six-cylinder Motors.—With the exception of the eight-cylinder motor, of which only a few have been made, and cannot be considered to possess a future from an everyday user's point of view, the six-cylinder engine would seem to be the last stage in motor design from the mechanical point of view that will be commercially possible, or even advisable. The one illustrated, fig. 21, represents the latest type turned out of the Napier factory at Acton, and the cycle of its working will be readily grasped by reference to the subjoined epitome. It will be well, however, first to note the *raison d'être* of this type of multiple-cylinder engine. Though theoretically the four-cylinder motor should give a reasonably constant series of impulses with an elimination of vibration in proportion to the method of the 'balancing' it has undergone, there is still left the inevitable period of angularity common to all reciprocating movements. This the six-cylinder motor with its cranks set at 60 degrees apart largely corrects, but of course does not entirely eliminate; in fact it is doubtful if such will ever be possible of accomplishment in any motor with a reciprocating movement. What steam engine designers have been largely able to effect by the balancing of moving parts—notably for example the Schlick, Yarrow, and Tweedy arrangement of the cranks in marine practice—will be hardly ever possible in the case of the single-impulse motor, but with these limitations in mind, the adoption of this type of multiple-cylinder motor should go far to effect the object in view. The other and, from the user's point of view, the more useful, is to be found in the increased amount of elasticity such an engine must give. It is obvious that an increased number of explosions or impulses in a given number of revolutions of the crank shaft must make for greater power throughout. Hence, with the improved carburetter and better throttle control, or rather the greater advantages that the system of varying the lift of the inlet valves provides, the elasticity and flexibility of the whole car is much increased. How far such a luxury as being able to throttle down the motor sufficiently

to enable one to thread one's way through street traffic without touching the clutch or dropping to a medium gear may be due to this latter evolution in the motor itself, or to the range of the modern carburetter, it is not our province here to discuss ; but granted that similar results are possible with the well-balanced four-cylinder engine, the result should be still more in evidence in one with a larger number of cylinders.

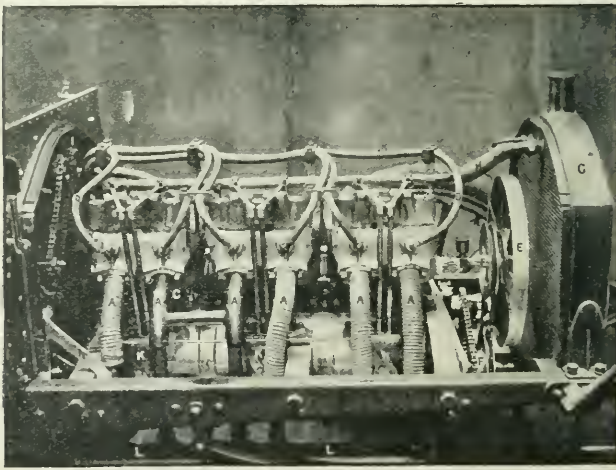


Fig. 21.—Side Elevation of six-cylinder Napier Motor

A, Exhaust pipes ; B, Moiv tappet rods ; C, Exhaust valves ; D, High tension wiring to plugs ; E, Fan for radiator ; F, F, Belt pulleys for fan drive ; G, Cellular radiator ; H, Water circulation pipe from top of cylinders ; I, Commutator chain from half-speed shaft ; J. Chain drive to multiple feed lubricator on dashboard ; K, Variable valve lift controlling lever ; L, Exhaust box ; M, Chain drive to water pump ; N, Stay bracket from dashboard to chassis

WATER CIRCULATION

With the high temperature evolved through the process of combustion of the gases, the temperature being approximately 2,000 deg. C. according to some authorities, it is essential to prevent undue heating of the affected parts. This is readily

accomplished by water jacketing the combustion chamber, and in large engines the cylinder also. The process of effecting this may be compared to the simple arrangement in vogue in a blacksmith's shop where the tuyére or bellows mouth is similarly jacketed to prevent its burning. The water is contained in a tank placed at a sufficient height to ensure its circulation under varying conditions of warmth. The water is led from the base of the tank to the tuyére, and thence by a return pipe to the top of the tank. This is a simple illustration of the gravity method of circulation in use on some cars, where it is generally called the 'Thermo Syphon' system of cooling.

Cooling by Gravity Circulation.—This method is extremely simple, and when perfectly adapted, very effective; it requires attention to practically only two points—sufficient volume or weight of water, and ample radiation surface through medium bore pipes with no sharp elbows or corners. The water enters at the lower end of the cylinder jacket, and accordingly, as it is heated, is forced by the heavier weight of the colder body to the top of the combustion head, thence through the radiator pipes to the top of the tank, whence it issues again to the base of the cylinder or combustion head. In proportion, as the head becomes heated, so is the velocity of the circulation affected, but with a well-proportioned cooling area the amount lost by evaporation or failure to be condensed is relatively very small. This is the system used on the Renault, Georges-Richard, Brooke, Argyll and other cars.

The Pump or Forced System.—For the purpose of ensuring a constant, as against a more or less intermittent flowing of the cooling water throughout the circulation system, many makers use some form of pump, driven either by friction from the periphery of the fly wheel, or by means of some positive system of chain or gear wheel—in the latter case usually intermeshing with the spur wheel on the shaft, which operates the valve mechanism. The block, fig. 22, illustrates one very popular type of pump used for this purpose, which effects the circulation by centrifugal force, hence its name. It will be

noticed that the rotating fan B is contained in a case E, with a delivery pipe at D. The fan is made with curved vanes V V cast on it, and is driven by a spindle A by means of a friction disc or gear wheel. The position of the pump is below the radiator, hence there is always a good 'head' of water issuing to the centre inlet C, whence it is ejected by centrifugal force at the pipe D, thence through the cylinder jacket and out at the top of the combustion head to the radiator and thence through the tank to the pump again at the inlet C.

The Rotary Pump.—The rotary type of cog-wheel pump is now being much used for the water circulation in motors. It

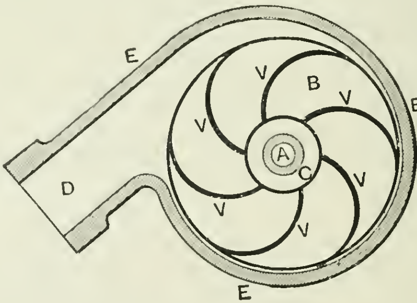


Fig. 22.—Centrifugal Pump

E E E, Pump casing; C C C, Suction area at centre of fan; B, Fan; V V V V, Fan blades or vanes; D, Delivery pipe; A, Driving shaft

consists of a pair of cog wheels placed in a closed chamber with but little clearance allowed, the water being caught, as it were, by the teeth and forced into the delivery pipe.

The Radiator.—As an integral part of either the gravity or forced system of water circulation, the radiator—as a means to an end—is indispensable, and its success is measured by its efficiency within the recognised limits of the space available for its fixing in the car. The two types in common use are the gilled tube and the honeycomb or cellular varieties, though the latter is superseding the former.

The Gilled Tube Radiator.—This type of radiator consists of

a length of thin copper tubing, either in its original circular condition, or flattened, the bore becoming elongated, and to this small flanges of thin sheet copper are soldered, the pipe being then bent to a suitable shape. Though varying in detail, the Loyal, Albany, Begbie-Audin, and the Sauerbier patterns have much in common, these being the best known of the tube variety.

The Honeycomb or Small Tube Radiator.—The honeycomb, or, as some term it, the Mercédès pattern of radiator because of its first being used by the Constadt Daimler Company, is really merely the application to the motor of the principle so long in vogue in the ordinary engine-room condenser, with the difference that air pressure takes the place of the water for the cooling effects in the former. Taking the Mercédès as the best known type, it may be described as a metal box of about 3½ inches wide, fixed in an upright position and pierced with some 4,000 or more small bore tubes. These are usually square in pattern, expanded, and then neatly tinned or soldered round the edges. Between the outer surfaces of these myriad tubes the small quantity of water is carried, and as obviously the cooling surface is so proportionally large for the body of water within the box, and a constant stream of air is being drawn through it by means of a high speed fan driven from the engine, the results are most satisfactory.

The Argyll New Pattern Radiator.—This is essentially an improved form of the tubular pattern radiator, and consists of two parts, an upper and a lower, coupled together by a series of vertically placed tubes, the air currents being made to impinge on wire gills of triangular shape, so arranged that the base of one coincides with the apex of another. In this way the air is caused to permeate in a series of thin streams deflected through the interstices of the several gills, the circulation being still further assisted by an induction fan in the ordinary way.

The Cooling Fan.—To ensure the more rapid circulation of the air through the cellular passages of the radiator, a small

belt-driven—or in some forms a friction-driven—fan is used. The type adopted consists of a small cast boss to which are riveted a number of blades, somewhat resembling a ship's propeller. These are so turned inwards as to cause an induced air current to be drawn through the radiator, at the same time the air is more or less deflected over the engine, tending to maintain a more equable temperature under the bonnet, and to prevent the rise of the noxious odours usually associated with heated machinery and oily exudations.

THE CRANK CHAMBER

The crank chamber, or base chamber, as it is usually termed, forms the base of the cylinder. Its use for lubricating purposes is very important. About half a pint of oil is kept at the bottom of this chamber, into which the crank dips at every revolution, thereby splashing up oil which lubricates the crank-pin, gudgeon-pin, crank bearings, crank-shaft bearings, the sides of the cylinder and the piston-rings.

THE PISTON

The piston used in motor-cars is generally known as the trunk type. It is composed of an iron casting which is made a good sliding fit in the cylinder; around its upper end three or four square-bottomed grooves are cut, and in these the piston-rings fit. The rings are made of cast iron, and the bore being eccentric to its outer diameter, there is a certain amount of spring in them, and so a gentle pressure is kept against the cylinder, preventing any of the expanding gases passing the piston. The piston is made to balance the crank.

Needless to say, the lubrication of the piston rings is of very vital importance, for on that depends the free working of the piston in the cylinder. In single-cylinder engines they require frequent attention, and paraffin should be squirted down the compression tap daily for cleansing purposes. Occasionally, too, the cylinder head should be taken off, and

the rings cleaned with a tooth-brush and paraffin. In double-cylinder engines it is very rarely necessary to clean the piston rings and top of piston, but paraffin should be squirted in daily.

APPLIANCES FOR STARTING THE MOTOR

The almost universal method of starting the motor is by means of a handle whereby the piston is operated and the charge drawn into the combustion chamber. In the case of cars with two or more cylinders various self-starters have also been introduced, which, on touching a button, explode the charge which remains in one or other of the combustion chambers, and so start the engine. These appliances, however, are only effective for a few hours after the engine has been running, as the charge gradually escapes.

VARIOUS TYPES OF ENGINES

There are various types of petrol engines on the market, but the main principles remain the same in all. The vertical engine is the most popular; then comes the horizontal, and in other cases engines worked at varying angles. When once, however, the motorist has thoroughly grasped the principle of the petrol engine, there is little difficulty in understanding these varieties. The same series of operations take place in the small single-cylinder engine of the motor-bicycle as in each of the four cylinders of the 100 h.-p. racing car.

CHAPTER VIII

IGNITION IN PETROL ENGINES

BY J. ERNEST HUTTON, A.I.E.E.

It has been explained in a previous chapter how the reciprocating piston takes in a charge of explosive mixture and compresses it. It is now necessary to ignite this compressed gas in some manner, in order that an explosion may take place and drive back the piston with great force.

There are two methods of accomplishing this in the petroleum spirit motor, (*a*) by means of a hot platinum tube, which is known as 'tube ignition'; (*b*) by an electric spark, known as 'electrical ignition.'

TUBE IGNITION

This system, at one time exclusively used for the ignition of motor-car engines, has now been almost entirely replaced by electrical ignition. More than a short description will therefore not be necessary.

At a convenient place in the wall of the explosion chamber is attached a platinum tube, closed at one end, and connecting with the interior of the chamber through a small hole. This tube is kept in its place by a brass nut packed with an asbestos washer. It is essential that the connection be perfectly gas-tight.

The position and length of this tube is defined by the manufacturer so that at the time of greater compression the explosive mixture is forced into the tube and ignited.

The Burner.—The platinum tube must be heated to a red heat by the small Bunsen burner placed directly underneath. The burner is on the well-known Bunsen system, taking in air through holes at the foot of the cowl, the air being carried upwards with the jet of petrol coming through the small hole in the nipple.

Although there are numerous designs of burners on the

market, they differ little from one another save in small details of appearance.

Petrol Supply to Burners.—There are two methods of feeding the burners with petroleum spirit :—

(1) By allowing the spirit to flow by gravity from a small tank fixed in an elevated position—this is known as 'gravity feed.'

(2) By forcing up the spirit from a tank—frequently the main supply—placed in a convenient position under the car by means of artificial pressure. This system is known as 'pressure feed.' The flame from a burner should be a bright blue, and directed lengthways on to the ignition tube.

Gas-tight Joints.—Should a leakage of gas from the cylinder occur at the joint between the tube and the cylinder wall, it will greatly interfere with the working of the engine.

To detect if there be one, hold a match close against the joint where the tube enters the cylinder, at the same time turning the starting handle. As compression takes place, gas will be forced through any leak, and will show itself by blowing the flame of the match. If a little petrol be poured into the cylinder and the same method of testing employed, the leak will be detected by the escaping petrol becoming ignited.

It is essential that the nut which holds the platinum tube in its place in the wall of the cylinder should be kept perfectly tight, a special 'box' spanner being required for this purpose to give greater leverage.

Cracked Platinum Tubes.—Sometimes the platinum tube becomes cracked, allowing the compressed gas to escape.

The same method as above may be employed to test this. A new tube must be inserted, with a fresh asbestos washer. Never use the same washer twice. Care must be taken that the new tube is of the same length and quality as the old tube, to ensure accurate timing.

Soot Inside Platinum Tube.—Faulty ignition is sometimes caused by the interior of the tube becoming blackened by sooty deposit, which prevents the gas becoming properly ignited.

Take out the tube and clear the interior with petrol and

a little waste or rag. If deposit still remains, use a piece of fine emery cloth wrapped round a small stick.

How to Light a Burner.—The burner must be thoroughly heated in order to vaporise the petrol before it is allowed to flow freely through it, and for this purpose small cups are provided at the base in which methylated spirits can be burnt. Some automobilists dispense with the use of methylated spirits for the preliminary heating; they merely flood the burner with petrol allowed to run through gently, and setting alight to it keep the flame constant until the burner becomes heated. This method is to be deprecated, as very liable to ruin the paint on the engine bonnet.

Burners sometimes 'jump'—this usually happens when first lit and not sufficiently heated. Time should be allowed for them to become thoroughly heated before attempting to start the car.

How to Extinguish a Burner.—When putting out burners blow them out with a length of rubber tube and allow them to cool down until the petrol flows freely through them, then turn off tap.

Faulty Burners.—When the flame burns yellow or on one side, it is because the burner is choked by some foreign body lodging in the nipple, and preventing the spirit from having free exit.

When it is desired to remedy a faulty burner, the wick should be withdrawn and a 'pricker' run down the stem and out at the hole in the nipple, care being taken not to injure or enlarge the hole. Small particles of soot and dust in petrol are causes of trouble. When cold, and the petrol turned on for a moment, the jet should leap up straight at the tube; if it quivers or is on one side there is something lodged in the nipple. The nipple must be removed and cleaned. Tight wicks, so frequently supplied by manufacturers, prevent the free flow of spirit; loose wicks are useless, as they are at once pushed up to the end of the stem by the pressure of the petrol, and stop the hole; the wick should be a good fit, neither too tight nor too loose.

Leakage in Pressure-fed Burners.—In pressure-fed burners, trouble is sometimes caused by leakage in the system of pipes, allowing the pressure to fall, or by water getting into them which has condensed in the pressure tank. *Caution.*—Before attempting to put a match near a burner, great care should be taken to be assured that the burner tap has not been inadvertently left on, and the engine box flooded. Many a good car has been burnt this way.

Burners Jumping Out.—Generally caused by too much pressure of petrol. The taps controlling the petrol supply to burners should only be opened a very little way—usually a quarter turn is sufficient.

Sudden bumps in the road will also cause jumping out.

Burners may also blow out. A proper wind shield should be fitted in front of the burner cage.

Spare Parts.—In connection with tube ignition it is necessary always to carry—

Spare platinum tubes.
Spare asbestos washers.
Spare nuts for tubes.
Spare burners.
Spare wicks.
Prickers.
A special spanner for undoing the nuts by which the platinum tubes are screwed into the cylinder.
A spanner for detaching burners from the supply pipe.
A spanner for removing the nipples of burners.

ELECTRICAL IGNITION

THE IMPORTANCE OF THE TIME OF IGNITION.—As we have explained above, the moment that maximum compression is reached the compressed gases are forced into the hot tube and become ignited. After each explosion a certain proportion of burned gas remains in the tube, and the rising piston causes

the fresh gas to mingle partially with this, but not sufficiently to ignite it until the greatest amount of compression is obtained. It is obvious, therefore, that with variable speed of engine, the moment of ignition is not always theoretically correct. In theory, that moment varies with the speed of the engine: many methods of timing 'tube ignition' have been suggested, but up to the present no satisfactory solution appears to have been discovered.

To get over this difficulty, and thereby greatly increase the efficiency of the motor, ignition by means of the electric spark has been devised. By the contrivance known as the shifting 'commutator'—afterwards described—it is possible to alter the moment at which the spark is caused to fire the charge in the combustion chamber, so that whatever the speed of the engine the moment of firing the charge is theoretically accurate.

Two Systems.—There are numerous types of electric ignition on the market, which may be divided up into the following classes:—

(1) With a battery and induction coil.
(2) The magneto system.

(1) Ignition with Battery and Induction Coil.—The essential of this system is an electric battery. The function of a battery is to supply the necessary quantity of electricity to create the spark in the combustion chamber. Broadly speaking, there are two kinds of battery used for this purpose on automobiles—viz. the 'dry battery' and the 'accumulator' or storage battery.

The Dry Battery.—The dry battery, so called because of the absence of any visible fluid, is used chiefly on motor cycles and very small voiturettes. It is not to be recommended for cars. Each battery is usually composed of four separate cells, coupled together in 'series.' The chief components of these batteries are usually carbon and zinc. The former forming the positive (+) pole, and the zinc the negative (−).

Poles.—When coupling up a number of cells to form a battery, the carbon of one cell is connected to the zinc of the next, and so on, until all the cells are connected, leaving one free wire at each end of the battery. These wires are known as the positive and negative poles of the battery.

Pressure of Electricity (*Volts*).—Each cell is capable of giving forth a certain small pressure of electricity. Pressure of electricity may be compared to the pressure of water in a pipe, or steam in a boiler, and is measured in units of pressure (volts).

Flow of Electricity (*Ampéres*).—Before, however, any current of electricity can pass out of the cell a complete 'circuit' must be formed between the two 'poles.' A quantity of electricity will then pass round this circuit in proportion to the pressure (volts) in the cell. This quantity or flow is measured in units known as 'ampéres.' One ampére flowing for one hour is known as an 'ampére-hour' and the capacity of a battery is measured in ampére-hours.

Coupling in Parallel.—If the capacity of one battery be insufficient, two or more may be joined up in parallel by connecting the positive poles together and the negative poles together. To obtain a sufficient spark a battery must be capable of giving out a pressure of at least four 'volts.' For this reason it is usual to couple up four dry cells together.

Disadvantage of Dry Cells.—As we have explained, the utility of a battery depends on its capacity in ampére-hours. Dry batteries do not give a constant output, but gradually 'fade'; while if allowed to stand idle for some time they usually exhaust themselves completely. For these reasons the accumulator or storage cell is usually preferred.

Two batteries are usually provided on each car, with a two-way switch connected in such a manner that either battery may be brought into operation at will, without stopping the engine. They are usually contained in a wood box, attached to a convenient portion of the frame.

Care should be taken that the batteries are kept apart by a

wooden division, and fit sufficiently well into the box to prevent them from being shaken by the violent jolting of the car.

Storage Batteries.—The great difference between a dry battery and a storage battery is that in the case of the latter when the battery is exhausted it can be completely recharged in a few hours. The 'accumulator' or secondary battery may be briefly described as a number of prepared lead plates, immersed in a weak solution of sulphuric acid and water. These lead plates are alternately positive and negative, and are separated from one another by thin strips of ebonite, glass, or other non-conducting material. The whole is contained in a square cell of some suitable substance, which is unaffected by the acid. The positive plates, which are connected together, may be easily detected by their chocolate appearance. The negatives (slate colour) are also connected together, and convenient brass screws (terminals) are fixed, to which wires may be easily attached.

The capacity of each cell depends on the size and number of plates. The pressure of any cell may be taken at two volts when working. Two cells, coupled in series, are therefore required to make a battery of four volts.

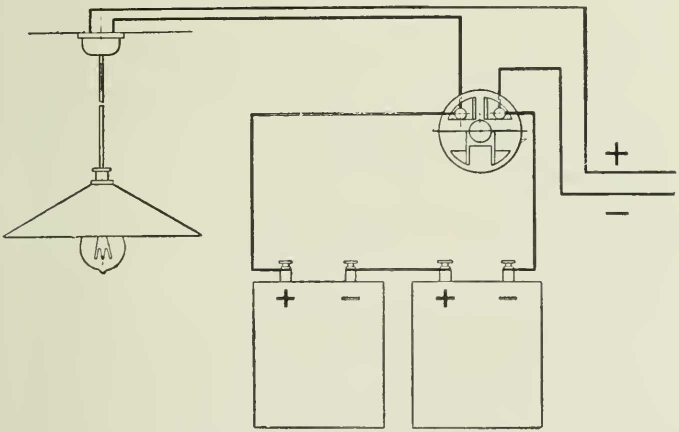
Charging Storage Batteries.—Accumulators require before use to be charged with electricity. This can be done by means of a large primary battery, small dynamo, or preferably off any continuous current electric light curcuit. In any case it is absolutely essential that the positive pole of the cell should be connected to the positive pole of the generator, and the negative to the negative. The positive pole of an accumulator is usually painted red and marked thus, (+). An easy way of finding the poles of a generator or accumulator is by placing two small strips of lead connected to the battery wires in a tumbler of acidulated water, and after passing a current of electricity through them, the piece of lead connected to the (+) pole will become chocolate. 'Pole-finding' paper may be also used for this purpose.

How to Charge Storage Batteries from an Electric Light

Installation.—If a supply of electricity be available, the cells may be easily charged off any wall switch (see diagram below).

The cell may be left on all night and found charged in the morning. No fear need be entertained of charging the accumulator too long. When fully charged the liquid in the cells assumes a milky appearance, and gives off a sound like gently boiling water.

Avoid Over-discharge of Batteries.—Great care should be taken to see that an accumulator is not discharged for a longer



period than its rated capacity. The pressure of an accumulator keeps practically constant at two volts per cell throughout the period of discharge. Immediately a drop in pressure is observed the cell should be recharged. Nothing ruins accumulators quicker than discharging them after the voltage falls. In no case should they be discharged to such an extent that the pressure of each cell falls below 1·85 or 1·9 volt per cell. The pressure may be conveniently ascertained by means of the instrument known as a 'voltmeter,' which will show at a glance the condition of any cell.

Care should be taken that the liquid in each cell well covers

the top of the plates. In process of time the liquid will be found to evaporate; this should be made up by a little clean rain-water, or preferably distilled water.

Switch.—It will be remembered that each battery has two free ends or 'terminals.' From one of these a wire is led to an 'interrupter' or 'switch.' This switch may take one of many forms. The effect of the apparatus is easily and quickly to complete or interrupt the circuit at any desired time in the same way that a tap is used to turn off water.

Induction Coil.—From the switch another wire is taken to an apparatus known as the 'induction coil.' The function of this is greatly to intensify the current. On a well-known electrical principle, the current, which is of low pressure (four volts), when it enters the coil, is intensified to a very great degree. The current being required to jump across a considerable gap inside the combustion chamber, a much greater pressure than four volts is essential.

To explain the method of connecting the coil with the battery and engine, it will be necessary to give a brief description of the coil. In the centre lies a bundle of iron wires, known as the 'core,' around which is wound a quantity of thick copper wire, insulated with silk or cotton. This wire is in one piece, and known as the 'primary' winding. On the top of this layer lie laps of very fine wire, likewise carefully insulated. This is known as the 'secondary' circuit. There is also usually contained in the same case an arrangement called a 'condenser,' which we need not describe. Although the two circuits are quite distinct from one another, a current of electricity passing round the primary and suddenly interrupted—by means hereafter described—will 'induce' a current in the 'secondary' of very great pressure. The ends of the two windings are led to the outside of the case, and terminate in screws or binding posts. These terminals are usually stamped with letters to indicate the method of connection. As many French coils are in use, it may help the novice to mention that the letter P stands for battery, M for commutator, B sparking plug, while in

the De Dion coils the brass rings on the outer case should be connected to the framework of the car, called 'earth.'

The Function of the Commutator.—Following the path of the current from the primary circuit of the coil, a wire is taken to the device known as the commutator. This takes many forms, which will be found under the description of the various systems.

The function of the commutator is to automatically make a break in the circuit, with the result that when the moment for firing arrives a flood of electricity at great pressure is induced in the secondary circuit.

The Sparking Plug.—In order to create a spark in the cylinder the wire from the coil is attached to a device known as the 'sparking plug.' This 'sparking plug' may be one of many forms, but all consist of a small central rod or wire, insulated by means of some non-conducting and heat-resisting substance, such as china, &c. The current flowing down the centre conductor finds itself compelled to jump a small gap to a piece of wire or other conductor let into the metal of the sparking plug. This jump gives rise to the spark which ignites the charge.

Gap-Jumps.—The introduction of a second 'jump' outside the cylinder and near the sparking plug, greatly increases the intensity of the spark given by the sparking plug, while it forms a convenient indication of the fact that a current is flowing.

The Return of the Current to the Coil.—The metal of the sparking plug being in contact with the metal of the engine, the current is conducted from it to the coil.

This is usually done through the metal frame or pipes, which, of course, are good conductors of electricity. These connections are, however, a frequent source of annoyance. The wires are often attached to the frame by small screws, which shake loose owing to the vibration from the engine and uneven surface of the road.

It must be clearly understood that, although the wires &c.

by which the circuit between the commutator and the coil is completed are technically known by the misleading term 'earth,' they are not used to convey the current to the ground but back to the coil.

Thus we have two complete electrical circuits acting in unison with one another. It is obvious that if there be any fault in the primary circuit no spark will be produced in the engine. Faults may arise from many causes.

Insulation.—Around wires intended to convey electricity are laid and woven many layers of rubber, cotton, &c. This lapping is to prevent the electricity which is being conducted by the wire from escaping, and is known as 'insulation.' On this 'insulation' the success of electrical ignition to a large extent depends, and the importance of keeping it perfect cannot be too greatly impressed on the novice.

The wires which convey the current from the coil to the commutator and from the commutator to the sparking plug have to be specially insulated, as the current, being at such a high pressure, will take every opportunity of leaving its legitimate path if allowed to do so.

All wires used for connecting the various parts of the systems should be very flexible, and composed of many strands of fine copper wire. Too much stress cannot be laid on keeping the insulation perfect.

If it be imperfect, the current will leave the wire and jump to the frame and thence back to the battery without performing the work required of it. When this occurs it is known as a 'short circuit.' Electricity always travels by the easiest path, and, if it can avoid doing any work, it will do so.

POSSIBLE DEFECTS IN ELECTRIC IGNITION.—*Imperfect Insulation.*—If a buyer have any doubts as to whether the insulation of the electric system of his car be sufficient under all conditions of weather and to withstand water splashed during washing the machine, &c., he would save much trouble in the future by having all the important wires sheathed in fibre or indiarubber piping.

Probably ninety per cent. of ignition troubles arise from faulty insulation.

Insulation Burnt.—A wire placed too close to an exhaust pipe invariably fails after a time, owing to the insulation becoming burnt by the heat of the pipe.

Insulation Cut.—A loose wire hanging against a sharp edge will invariably chafe through in course of time.

Insulation of Coil.—If the insulation of the coil break down it cannot be repaired on the road, it must be returned to the makers. A small ticking is usually audible inside when this occurs, when the current is turned on.

Coils placed too near the engine are liable to break down, as the heat is injurious to them. They must be fitted in a cool place.

Insulation Chafed.—Wires laid across moving parts, brake connecting rods &c. will sooner or later give trouble.

Loose Connections.—All wires when joined together should be carefully soldered, the joints being afterwards insulated with rubber or prepared tapes. Never make a joint in the secondary wire. See that all terminals are tightly screwed up. Special attention should be paid to the 'earth' connections, which are a constant source of trouble. When connecting insulated wire, the insulation must be bared back, so that only the bare wire is attached. Wires sometimes become broken, and being loose make partial contact.

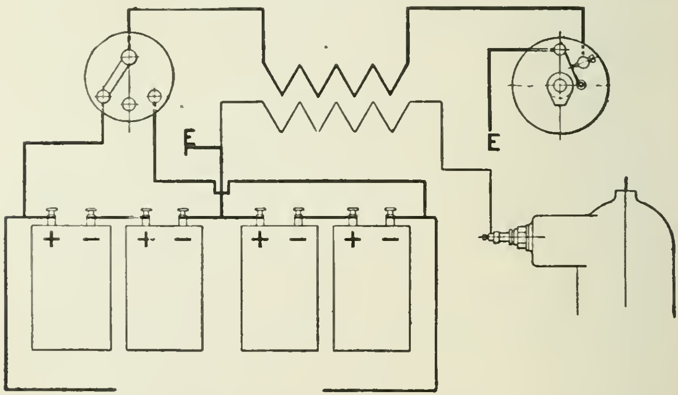
Dirty Connections.—Dirt is a non-conductor, and should be avoided on the electrical system, as on the rest of the car. Battery terminals frequently become corroded from acid fumes; they should be covered with vaseline, and require periodically cleaning. See that all connections at the coil are clean.

Broken or Defective-sparking Plug.—The porcelain may crack and the current jump across the fracture. The points may be sooty and require cleaning. They may be touching and require separating, or they may be too far apart. The usual distance between the points is about one sixty-fourth of

an inch, which is approximately the thickness of a thumb nail.

Dirty Commutator.—Clean all contacts from oil and dirt. Most commutators are so placed as to give the maximum possible opportunity to collect oil and dirt. They should always be provided with a cover.

Batteries.—In course of time the batteries will become weak or discharged. Always carry a spare set. A two-way switch should be provided on the car so that in a moment the spare set can be brought into use. The diagram shows the

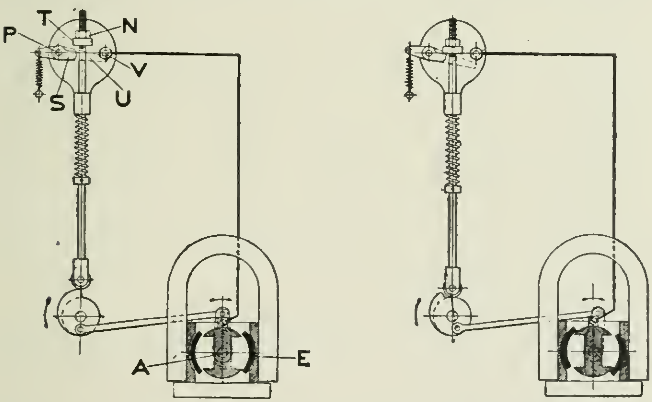


method of connecting up the switch, while both batteries may be charged together without interfering with the connections.

(2) Magneto Ignition.—From the list of possible failures given in the last section, it will be inferred that there are many faults liable to occur owing to the multiplicity of wires, batteries, coils, and the like. To obviate these difficulties, electricians have designed a little machine known as the 'magneto-generator.'

Simms-Bosch System.—Perhaps the best known of this

type of machine is the 'Simms-Bosch.' The magneto consists of a number of horseshoe-pattern magnets supported on a metal base, on the inner faces of which are fastened two pieces of metal known as pole-pieces, provided with hollow faces, within which is fastened an H-shaped piece of soft iron (armature). The channels of this armature are filled with insulated wire. In the space between the armature and pole-pieces a 'shield' or tube of soft iron is caused to oscillate. To one end of this shield is attached a crank, operated by a connecting rod from the half-speed shaft on the engine.



When the shield is caused to oscillate rapidly, currents of electricity are induced in the winding of the armature. These currents are led away through a connected insulated wire to a special device which automatically makes and breaks a circuit in the interior of the combustion chamber. The action is as follows :—The wiper U is normally at rest upon the stud V, which is brought through the wall of the combustion chamber and terminates in a nut to which the wire from the magneto is attached. At the other extremity of U is attached a small rod brought through the flange and connected to S, which is capable of moving about a pivot P. This pivot is in electrical

connection with the other end of the armature-winding, through the metal of the engine. When the moment of firing arrives the striker T is caused to drop smartly on S, causing U to separate from V. At the same moment the shield E assumes such a position with regard to A that a current is induced in the windings on A, and being conducted through the connecting wire, a spark is caused to pass between the points of U and V igniting the charge in the engine.

POSSIBLE DEFECTS IN THE SIMMS-BOSCH SYSTEM. — (1) *Failure of Insulation.*—The stud which is brought through the wall of the combustion chamber has to be most carefully insulated from the metal flange in which it is placed. If this fails, the current will jump across to the frame of the motor in a similar manner to that of a broken sparking plug. The insulation is sometimes burnt, and great care is necessary to make it good again, thin washers of mica being used.

(2) *Failure of Magnets.*—After long use, the magnets are liable to lose their magnetism, thereby reducing the intensity of the spark. The only remedy is to return them to the makers to be re-magnetised.

(3) *Faulty Adjustment.*—It is obvious that the position of the shield at the moment of firing must be absolutely accurate. The diagram opposite shows the relative position of the various parts, and, to assist the novice in accurately adjusting them, the following instructions are appended :—

Remove the top plate of the magneto machine by unscrewing the screws at the corners ; the moving parts of the machine will then be open for inspection. Turn the engine gently round till the ignition point is reached, i.e. when the ignition rod drops, observing carefully the direction in which the oscillating shield E of the magneto machine is moving ; at this point the side of the envelope moving from the armature A should be clear of the same by about one-sixteenth of an inch. The setting can be done by varying the length of the magneto driving rod if adjustment be provided there, or if not by loosening the nut at the end of the magneto spindle and

gently tapping the edge of the armature till the correct setting is obtained. The final adjustment should be made on the tappet T, which should strike the sparking lever S about one-sixteenth of an inch before reaching its lowest point, the exact distance being found by examining the spark (turning the motor smartly round for this purpose) and adjusting the tappet till the best spark is obtained. The lock-nut N should then be screwed up.

HIGH-TENSION MAGNETO.—To do away with the use of the mechanical make and break inside the combustion chamber, many makers are now fitting a 'high tension magneto system.' This consists of a rotary magneto machine driven off the engine, the current being generated at a low pressure and transformed by a coil in a somewhat similar manner to the battery system. A special form of commutator has to be used. Ordinary sparking plugs are fitted. In fact, the system is just like the battery and coil ignition, with a small dynamo replacing the batteries.

DE DION TYPE OF IGNITION.—We will now describe the ignition fitted to some of the best known types of engines.

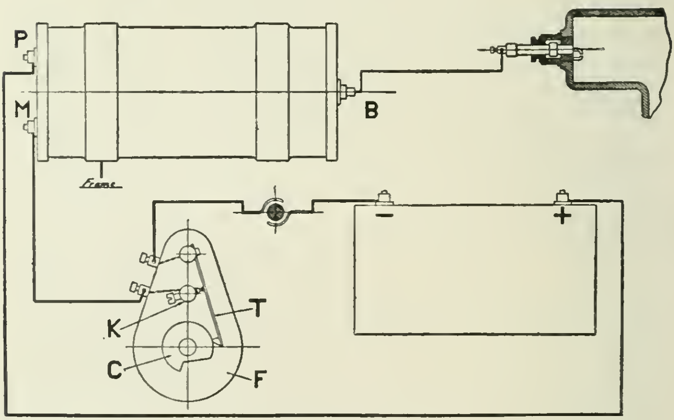
De Dion et Bouton.—This well-known firm may be said to have set the fashion of electric ignition in the smaller engines. The system they employ belongs to Class I.

The most notable feature is the commutator. This device consists of a cam or disc C, fastened to the half-speed shaft of the motor, and provided with a wedge-shaped notch. Around the cam is attached a pear-shaped plate F constructed of good insulating material, such as ebonite, to which are attached a spring vibrator or 'trembler' T, and a brass pillar in which is fastened a platinum-pointed screw K. The trembler is provided with a platinum stud or 'contact' about the middle.

The Action of the Trembler.—The action of this trembler is very simple. Normally the end of the trembler T presses on the cam C, the platinum contacts on T and K being a little apart. If the engine be now turned round until the time for firing the charge arrives, the trembler will be seen to fall into the notch in the cam, allowing the two platinum points to come

into contact. If the distance between the contacts be correctly judged, the trembler will vibrate freely, thereby causing several 'makes and breaks' in the circuit. As previously explained, a stream of sparks will result in the combustion chamber.

And, as also explained, it is necessary to alter the moment of firing the charge.[1] To effect this the plate F is designed to be moved backwards or forwards easily in relation to the cam C. The effect of this is to bring the point of the trembler a little higher up or lower down, causing it to enter the notch



earlier or later, so that the moment of contact and consequently the spark is varied according to the will of the operator. The faster the engine runs, the earlier must be the spark.

HINTS ON WORKING THE DE DION IGNITION.—*Adjustment of Trembler.*—On the correct adjustment of the trembler and the screw K much of the success of the De Dion

[1] So that it may accord with the speed of the engine, i.e. earlier in the engine stroke for high speed and later for slow speed.

system depends. The means of adjustment is as follows: Unscrew the sparking plug, and attaching the 'secondary' wire, lay the metal portion of the plug on the top of the engine, care being taken that the terminal is well away from any metal. Now smartly turn the motor starting-handle, when a stream of sparks should be observed to cross between the points of the plug. When the trembler is over the notch in the cam, it should have so far entered it as to be resting on K when it is half in. If the bottom of the trembler be lifted with the finger and allowed to drop quickly there should be a regular hum or buzz. After a little practice the novice will be able to recognise the correct position for the screw K by the hum of the trembler. It should be remembered that, though a stream of sparks may pass between the points of the sparking plug when it is removed from the engine, it does not follow that the same effect will be produced under the conditions of highly compressed gas found in the cylinder.

Moisture is a frequent cause of trouble on motor-cycles. Rain or damp may lodge on the porcelain of the sparking-plug or between the terminals on the ebonite plate on the commutator, or between the terminals of the coil. *Remedy.*—Carefully wipe the affected parts with a dry rag and cover them with a little oil or vaseline.

Battery Short-circuited.—Spanners, oil-cans, tire-pumps, &c., have been known to jump on the top of batteries, thereby connecting the terminals together and causing a 'short-circuit.' *Remedy.*—Always carry the battery in a separate box, away from other things.

Burnt Contacts.—The contacts may become burnt. They should be cleaned up with a smooth file.

Loose Contacts.—The platinum points on the trembler can become loose. They should be knocked up with a light hammer.

Oil on Contacts.—It frequently happens that oil and dirt accumulate on the platinum contacts, which interrupt the free

flow of the current. Care should be taken, therefore, that they are perfectly clean.

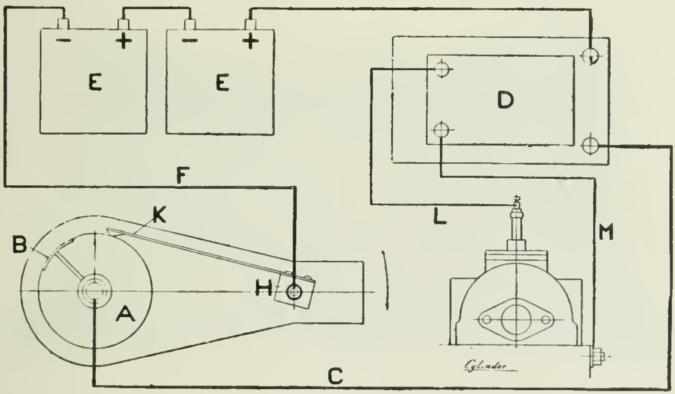
Retard Sparking for Starting Engine.—When starting a motor the spark should always be placed as late as possible.

THE BENZ IGNITION.—This system is practically identical with that used by Messrs. Panhard-Levassor, Daimler Co., Napier & Son, &c. While the general lines of the De Dion have been followed, one important variation is introduced—viz. the alteration in the position of the trembler. In engines running at a lower speed than 1,000 revolutions per minute the De Dion is not found to answer satisfactorily, and a different method of causing a vibratory contact had therefore to be devised. On the Benz system the notched cam is replaced by a round fibre disc A, a brass strip (B) being attached to it over one-eighth its circumference. This strip is connected with the iron axle on which the sleeve revolves. A spring (H) to which is attached a knob, K, rests upon the disc. A wire connects it with the battery. It will be seen then that as the disc revolves the plate B will pass beneath the spring K, thereby completing the electrical circuit from the battery through K B, and on to the metal of the motor, whence it returns to the coil. To effect the rapid interruption of the current a trembler is provided on the coil. The action of this is as follows :—

When a current is allowed to flow round the thick or primary winding of the coil, the iron wires, which it will be remembered composed the core T, become magnetised, and attract the iron knob R of the spring armature. The current for this purpose is led through the screw S to a platinum point on R. The moment this occurs the contact-piece on R leaves the point of the screw S, with the result that T instantly loses its power of attraction ; this action is repeated with great rapidity so long as the circuit is completed by B and K. The screw S requires to be adjusted in just the same manner as K in the De Dion system, though it must be remembered that the action is reversed, the trembler being in contact with it so long as B and K are apart. In engines provided with two or

more cylinders an easy method of testing the spark in each cylinder becomes apparent. In most systems a separate coil is required for each cylinder. Having put the engine in motion, depress with the fingers all the tremblers except one, allowing each trembler to vibrate separately. Should there be a faulty cylinder, it will at once become apparent, and the cause easily located.

The commutator used on the Napier cars has been placed in front of the driver and covered with glass, so that the sparking at the points is easily viewed. A chain driven off the half-



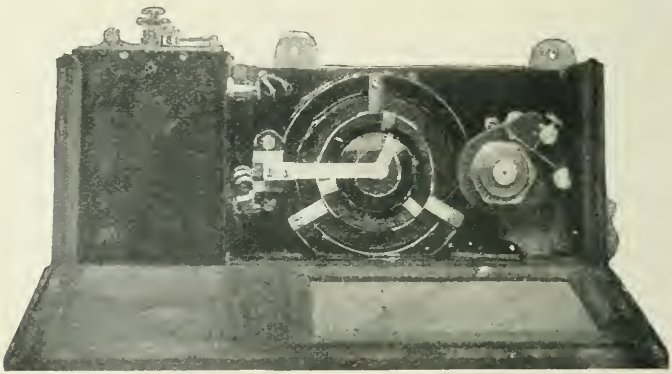
speed shaft causes the centre disc to revolve. A special form of contact is used, which possesses the great advantage of being unaffected by oil. In other respects the system closely follows the Benz.

The Canstatt Daimler Co., Messrs. Mors &c. are at present using the magneto system.

NAPIER IGNITION

This special form of ignition, which has been brought out by Messrs. D. Napier & Sons for use on their six-cylinder car, is another attempt to obtain greater reliability by using

only one trembler. The chief novelty consists in the special form of commutator employed which can be readily seen from our illustration. On the right hand side is mounted the contact piece. The high tension commutator is so arranged that contact is actually made before the low tension circuit is completed. All wear due to 'arcing' on the contact of the high tension commutator is therefore obviated. The whole apparatus is mounted in a suitable box with glass cover attached to the dashboard, and commutator and make and break are driven by means of a chain from the engine.



Napier Ignition

WILSON & PILCHER SINGLE-TREMBLER MULTIPLE INDUCTION COIL

In order to obviate the use of a large number of tremblers Messrs. Wilson & Pilcher have designed a system in which only one trembler is made to do duty for any number of cylinders. The advantages of a single high-tension coil are therefore combined with those of a low tension commutator and connections while great uniformity and accuracy in the time of firing is obtained The illustration clearly sets out the arrangement, and it will be noticed that each cylinder is provided with a switch which greatly facilitates testing.

HIGH TENSION MAGNETO IGNITION

This system is coming much into favour, having been adopted by Panhard et Levassor, &c. The system here described is that of the Messrs. Simms and is practically identical with that of other makes.

The armature A (fig. 1, p. 164), which is stationary, is provided with two windings A 1 and A 2, of which A 1 is of stout

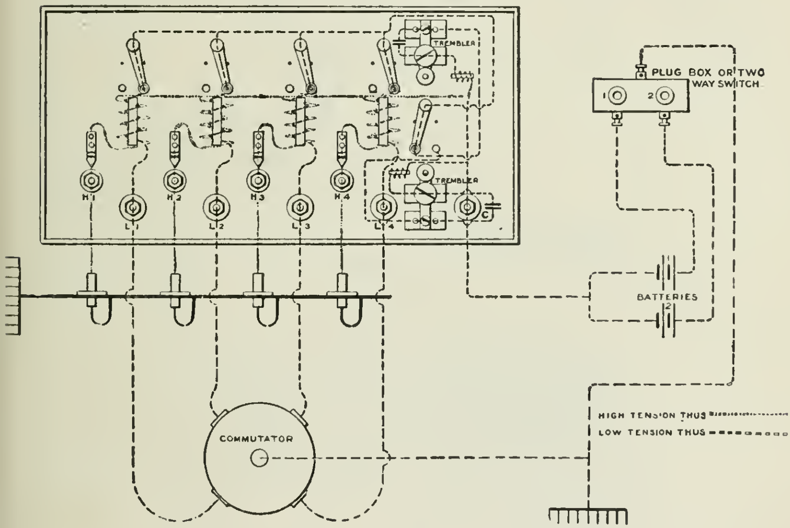


Diagram of Connections of Wilson-Pilcher Ignition

wire and corresponds with the primary winding of an induction coil, A 2 being of fine wire and corresponding to the secondary. One end of the winding A 1 is earthed on to the shaft of the machine, while the secondary winding forms a continuation of the primary.

The other end of the primary winding A 1 is led to one side of the contact breaker B 3 and to one terminal of the condenser; the other terminal of the condenser and the moving arm of the contact breaker B 3 being earthed.

As in the low-tension magneto, the changes of magnetism in the armature core, which give rise to the primary alternating current, are produced by the rotation of a soft iron sleeve B, which partially surrounds it and is integral with the hollow shaft B 1, which also carries the notched disc B 2 and the high tension distributing disc or commutator D. The action of the

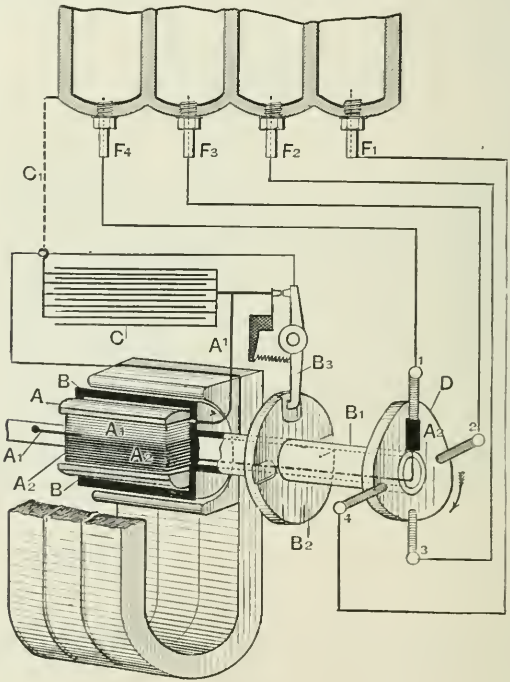


Fig. 1

sleeve B is exactly the same as in the case of the low-tension magneto, but as some readers may not be familiar with this we will briefly recall it.

If the sleeve B entirely encircled the armature it would shield it completely from the action of the field magnets. It does not, however, entirely encircle the armature, but is made,

as is shown in fig. 2, in the form of a tube in which two slots opposite each other are cut, each leaving open a space of about 90° of a circle.

When the sleeve is in the position 1 in fig. 2, a maximum of lines of force pass through the armature, entering at the top of the armature and coming from the left side or the north pole shoe of the field magnet. The change of the lines of force in unit time being at this moment nil no current is induced in the armature winding. In position 2, the sleeve has been

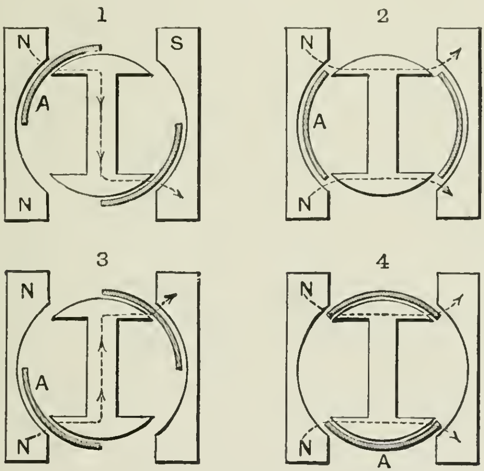


Fig. 2

turned from right to left through an angle of 45°, and the two segments, so to speak, magnetically short circuit the two sides of the armature, so that no lines of force pass through the core of the armature. Therefore a decrease of the lines of force from maximum to nil has taken place, and a current has been induced in the armature winding in a certain direction, the latter being dependent upon the direction of the lines of force as well as the kind of change in them, i.e. increase or decrease of them.

Position 3 corresponds with position 1, excepting that the

lines of force pass in maximum numbers from the bottom to the top of the armature, the induction being in this position again nil. In position 4 the sleeve has been moved from the position 1 through an angle of 135°. Since in this position each of the sides of the armature is in magnetic connection with each pole shoe of the magnets through the slots in the sleeve, no lines of force flow through the core of the armature. Thus from position 3 to position 4 a decrease of lines of force from maximum to nil has taken place, and, as explained before, a current has been induced in the armature winding.

The direction of this current is the reverse to the one in position 2, because the direction of the lines of force is different, the induction being at its maximum. If the sleeve be turned further through an angle of 45° the position shown in position 1 is again arrived at, so that at this moment the induction in the armature winding is again nil.

It will, therefore, be seen that the induced current reaches its maximum four times in each revolution of the sleeve.

Since the induced electro-motive force is directly proportional to the number of changes of the direction of the lines of force per second, it will be understood that the faster the sleeve rotates the stronger will be the induced current.

Having now explained the way in which the primary current is produced, we will proceed with the description of the high-tension machine of which this forms a part.

The contacts of the contact breaker B 3 are normally held together by the action of the disc B 2, and during these periods the low-tension winding A 1 is closed on itself, so that a powerful current flows through it at the moment when the magnetism of its core is being varied by the rotating sleeve B. When one of the notches in B 2, which are steep on one side and bevelled on the other, comes under the lower end of the contact breaker arm B 3 the latter snaps back, owing to the action of its springs, separates the two contacts, and breaks the circuit of A 1. This produces a high-tension current in the secondary or fine wire winding A 2, just as in an ordinary induction coil the condenser

C increases the effect in the well known way. The secondary winding being connected to the primary as already described and as it is earthed through it, successively connecting the central rods of the sparking plugs F 1, F 2, F 3, F 4 to the opposite end of the secondary A 2, causes sparks to pass in the four cylinders at the right moment, the tension or voltage of the primary and secondary being added to one another. The distribution is effected by the commutator or distributor D. This consists of a rotating disc D, carrying the metal plate A 2, which is in conducting connection with the insulated end of the secondary winding A 2. As the disc revolves this metal plate makes contact successively with the fixed carbon collectors, 1, 2, 3, 4, which it does in each case just before the notches in B 2 cause B 3 to break the primary circuit A 1. Sparks, therefore, take place at the required moment in the four cylinders.

The time of ignition is advanced or retarded by means of a small lever, which is a part of the machine, and which causes the contact breaker B 3 to act earlier or later as required.

The spark produced by this magneto machine is a combination of the low and high tension, the low-tension spark being used to start the arc, which is immediately followed by the high-tension spark. The smaller the low-tension spark at the contact breaker B 3, the more powerful will be the following high-tension one.

That is to say, if the primary current is broken during an induction period such a high voltage is created in the secondary winding that the air gap between the two electrodes of the ignition plug is bridged and a strong spark is produced.

CHAPTER IX

THE CAPRICES OF THE PETROL MOTOR

By the Hon. Charles S. Rolls

The intending owner of a motor-car will often say, 'What in the world should I do if the thing were to break down on a lonely country road?' and the object of this chapter is to enable the novice *en panne* quickly to recognise the symptoms of his case (so far as the engine is concerned) and then at once to 'spot' the probable cause and remedy.

In order to make these remarks complete, I have been compelled to enumerate a very long and somewhat formidable list of evils, and lest a glance at this should frighten off any would-be motorist, it must be clearly understood that the list comprises *possibilities* as distinct from *probabilities.*

What is here said should therefore be looked upon in the same light as a veterinary surgeon's book on horses, and readers must not think that if they purchase cars all the troubles here mentioned would necessarily occur to the motor any more than they would imagine that all the diseases described in a horse-doctor's book would happen to a newly acquired horse. Many cars have been run by amateurs for thousands of miles without the occurrence of any trouble. In proof of this I may observe that a member of the Automobile Club recently stated that, although he had previously no engineering experience, he had run his car ten thousand miles without having to effect any serious repairs, and had met with no trouble whatever except on two occasions, when the slight repairs necessary were done in a very short time.

The chapter is divided into two parts, the first dealing with the 'Difficulties in starting,' and the second with 'Troubles on the road.'

Part I

THE MOTOR WILL NOT START

A petrol engine will generally start most easily with all the cold-air inlets closed, the usual procedure being to shut these taps or inlets, let a little petrol into the carburator, and shake the float needle (if there be one) or inject petrol into the induction valves or through the compression tap on top of the cylinder if such exists; then, the electricity being switched on and ignition retarded, a turn or two of the engine should set it going; if, however, it will not start, the trouble must lie in one of the following sources:—1. Ignition; 2. Carburation; 3. Compression; or 4. Moving parts.

1. *Ignition.*—Having satisfied yourself that the ignition is in perfect order (see Chapter VIII.), the fault must be in one of the three sources remaining.

2. *Carburation.*—Let us first take the Carburation. There are many little things which may militate against a healthy explosive mixture reaching the cylinders when starting the engine, and we will first enumerate the principal causes in brief as follows:—

(*a*) Wrong proportions of air and gas.
(*b*) Carburator flooded.
(*c*) Carburator starved.
(*d*) Excessive cold.
(*e*) Inferior petrol.
(*f*) Starting handle not turned fast enough

To deal with these more fully:—

(*a*) If difficulty is experienced in starting, the mixture of hot air, cold air, and petrol vapour should be varied in every possible way—see also than an excess of air is not being drawn in through a crack in a pipe or a loose coupling, or through the supplementary air-valve having stuck open, in the case of an automatic carburator.

(*b*) Too rich a mixture may be caused by the presence of too much petrol in the carburator; if this is so, turn off the petrol supply for a time and revolve the engine again with all air inlets wide open until the first explosions are obtained; 'flooding' of the carburator may be caused by (i) dirt preventing the valve shutting properly, (ii) the float leaking [see p. 178 'carburator flooded'], (iii) the float may be too heavy and not rise high enough to shut the valve, or it may be unevenly weighted which might cause it to stick, or (iv) too much shaking of the float needle by hand.

(*c*) Perhaps the cylinder cannot get any petrol vapour, owing to the nipple (in a spray type carburator) being stopped up. This nipple can be taken out with a special key and cleaned by passing a fine needle through it, taking great care not to enlarge the hole in the least degree. Possibly there is no petrol in the tank, or you have forgotten to turn it on, or the tank is almost empty and the car tilted by standing at the side of the road (in which case push it over to the other side). One can tell if there is any petrol in the carburator by the position of the float needle, and the novice should provide himself with a diagram of his carburator.

(*d*) In cold weather, if the car has been standing idle for some time, considerable difficulty may be experienced in starting up. Petroleum spirit will of course vaporise far less readily at a low temperature than at a high one. Artificial heat is therefore the remedy, and this can be most easily applied by taking out the mushroom-piece (if there be one) in the carburator, and warming it over the burners or otherwise; a hot iron may be held against the carburator, or warm petrol may be squirted into the cylinder or induction pipe or valves. In obstinate cases it may be necessary to warm the carburator underneath by means of cotton waste soaked with methylated spirit. There may be a slight flare up, but this will assist the carburation, and there is nothing to fear from it so long as the main supply cock has been carefully closed.

(*e*) *Inferior Petrol.*—The petrol remaining in the carburator may lose its strength and become stale if the car has been standing a long while; it should be emptied out and refilled. A good plan when about to put away the car for some time is to stop the motor by turning off the main cock, so letting it use up the last drop of petrol in the carburator.

The petrol in the main tank will also become heavy in course of time, especially if free access of air is allowed to it. A small instrument called a densitometer is sold for determining the

specific gravity of petrol ; the best specific gravity for starting is ·680 ; if your petrol when tested shows heavier than sp. gr. ·720 it should be changed or the tank shaken up.

There may also be water in the petrol owing to its being poured through a sufficiently fine filter.

(*f*) Perhaps there is nothing wrong after all, except that you do not turn the starting handle fast enough to cause proper vaporisation. Remember that a few smart turns with the whole of your energy will be more likely to start an engine than hours of slow 'grinding.'

3. Having now ascertained that neither the Ignition nor the Carburation is to blame, if the motor still will not go we must look for the failure in either the Compression or one of the moving parts.

Compression is the life and soul of a modern high-speed internal combustion engine.

When the engine is in proper working order, and being turned by hand, a considerable resistance should be felt at the alternate back stroke of each piston ; this back pressure should require a considerable effort to overcome when the handle is being turned slowly. If the compression of any cylinder leaks, that cylinder will not give off its full power.

How to Locate a Leak of Compression.—If there be a loss of compression, a slight hiss will generally be audible when the handle is turned. In order to find out where the leak is, a lighted taper may be held over the cylinder in different positions, while the engine is being turned slowly, having first shut off the petrol supply ; the flame will be blown on one side on meeting the leak ; or soap and water may be painted about the cylinder head, and bubbles should soon indicate the presence of the leakage.

Possible Sources of Leakage.—(*a*) A leakage will generally be found at the junction of such fittings as the sparking plug, induction valve, valve cover, compression tap, ignition tube, or other attachment connected with the interior of the cylinder or combustion chamber—probably a broken sparking plug, a washer blown out, or a loose nut will be the cause.

Should, however, the leakage not reveal itself under the above tests, it is probable that

(*b*) the exhaust or inlet valves are 'pitted' or coated with deposit, and consequently permit a loss of compression past their seating; if this is so, they should be taken out and ground on their seats with fine emery flour mixed with oil or paraffin, till they bed properly; the engine may then have to be run for some time before the leakage ceases. See also that the valve springs have not grown too weak.

(*c*) There is a possibility of the compression also blowing past the piston-rings. This can generally be detected by listening attentively with the ear close to the cylinder at fault, and turning the starting handle or fly-wheel slowly—a gentle hissing will be heard at intervals. The cause of this is generally the sticking of the rings in their grooves. The remedy is to wash out with paraffin so as to free them for their whole circumference. If they still leak badly, the piston should be taken out and new rings fitted, especially if the engine has been over-heated at any time, in which event

(*d*) the cylinder-head joint, if there be one, may have warped and the compression may be escaping from one cylinder to the other, or into the water space; water in turn will probably find its way into the cylinder, and being converted into steam will interfere with the working of the engine and rust the valves. Little spots of rust on the valves will indicate what is happening, and the cylinder-head joint will then have to be re-made—a matter for an expert.

No Compression at all.—If on trying to start the motor no compression at all is felt on one cylinder, there may be a valve stuck open through a breakage or 'gumming' (see later), or else the ends of the piston-rings may have by chance arrived opposite one another, thus allowing the compression to slip through the spaces. When this occurs, the rings should be freed by letting in paraffin and running the engine a bit on the other cylinder or cylinders if possible; the rings will probably soon change their position—they are purposely allowed (in many engines) to move round so as to wear evenly.

Apparent Excessive Compression.—There may, especially on a cold morning, appear to be so much compression that the engine can hardly be turned; this stiffness is really due to

the drying of the oil on the walls of the cylinder. To avoid this a dose of paraffin should always be injected into the cylinders when stopping the engine after a day's run.

Note.—It is most essential for every motorist to insist on having proper and convenient means fitted on his car for washing the cylinders with paraffin or petrol, both to facilitate starting up and to keep the piston-rings in good order.

Back Firing.—I have said that a considerable resistance should always be felt when turning a motor slowly by hand; sometimes, however, the innocent motorist, when endeavouring to put his engine into motion, receives something considerably more than a mere resistance. He may get a kick from the handle which will give his arm a nasty jar, and possibly sprain his wrist. These 'back fires,' as they are termed, are the result of what is called 'premature ignition,' and therefore belong strictly speaking to the chapter on 'Ignition.' I may merely remark that they are due to the spark-timing gear being too much advanced, overheating of the motor, or (in the case of tube ignition) to the platinum tubes being too long, the burners being too close in, or ignition tubes being too hot; in the last case the burners may be turned down to allow the tubes to cool momentarily and turned up again when the motor starts. In the other cases the remedies are obvious.

4. *Moving Parts.*—Having exhausted the possible causes of refusal to start except those consisting of some mechanical fault, we will now see what moving parts could go wrong, and so cause all the trouble.

(*a*) The mechanism for operating the electric ignition is liable to many little derangements (see Chapter VIII.).

(*b*) A broken exhaust or inlet valve stem or a broken or displaced spring will often be difficult to observe; a valve may have stuck open through burnt oil or dirt on the spindle, or the spring being too weak, or through something getting under its seat. The valve gear should be examined in motion to see that all the valves work regularly and to their full extent.

(*c*) Stiffness in the accelerator or governing gear, or a

dislodged key, pin, or feather may also hinder the lifting of the exhaust valves, or on some engines prevent the throttle from opening itself fully.

(*d*) The means adopted on some cars to engage the starting handle with the motor will sometimes fail, so that the handle will not turn the motor. In the Panhard starting gear of the old type, the handle is made to engage with the engine by pushing a small bevel-ended tongue in against a pin put through the end of the crank-shaft; a bad 'back fire' may cause this pin to sheer off or bend and jam the tongue. The novice should be shown the way to get at this mechanism so as to know how to renew the pin or tongue on the road if required. If the starting gear fails at an awkward moment, the car may be started by putting in the second or third speed and pushing the car with the friendly aid of a few lookers-on.

PART II

ROAD TROUBLES

We will now pass on to Part II., dealing with possible troubles (with the engine) encountered on the road, dividing this section into—

1. Motor stops completely.
2. Motor nearly stops and then goes on again with full power.
3. Motor will not 'pull' well, or misses fire.
4. Motor will not govern or 'cut out' properly.
5. Unusual noises.

1. MOTOR STOPS COMPLETELY

This may be divided into—

A. Overheating.
B. Starvation of carburator.
C. Carburator flooded.
D. Burners going out.
E. Mechanical reasons

A. *Overheating.*—The most serious cause of a stoppage on the road is undoubtedly overheating, which causes the lubrication to burn up and the piston to expand and grip or 'seize' in the cylinder. This matter of overheating should be subdivided into its various causes, viz. :—

Cause 1. Water circulation fails.
,, 2. No water.
,, 3. Faulty lubrication.
,, 4. Water entering cylinder. }
,, 5. Too powerful a charge. } very unusual.
,, 6. Incrustation of jackets. }

Cause 1. *Water Circulation Fails.*—Of these causes the cessation of water circulation for cooling is the most common. It must be the result of (*a*) the pump ceasing to act through bad adjustment of its driving-gear, or through its valves or cogs jamming, its spindle being seized or bent, the interior fan worn or unkeyed, the friction wheel unkeyed, or its tyre worn out or become detached.

As regards the adjustment of the driving-gear of a centrifugal pump driven by friction, the friction wheel and spindle should revolve freely when the pump is pulled away from the fly-wheel. It should be adjusted so that the spring presses it lightly but firmly against the fly-wheel; care should also be taken in packing the glands of these pumps, for they run at a very high velocity; a very slight leak of water, however, is advantageous for lubrication.

(*b*) The blockage of a water-pipe or passage, or

(*c*) An air or steam lock in the pipes. The best way of getting rid of an air lock is to open all cocks and plugs in the water system and then run the engine, filling up the tank and water jackets to make up what is running out. This will eventually expel any air, and the water will circulate freely.

Cause 2. *No Water.*—If all the water has been lost on the road through the breakage of a pipe or the opening of a plug or tap, or loosening of a joint, and no water is near, you can continue your journey spasmodically by allowing the engine to cool down, then run on a mile or two with the bonnet off or open until it shows symptoms of overheating again, when stop, paraffin your cylinders, and wait another half-hour or so. The pump of a car has several times been known to have been carried away by contact with a dog; in one case there was no trace of pump or dog except a tooth which the unfortunate animal left in the back tyre!

Note.—Always carry rubber tubing to repair ruptured pipes.

Cause 3.—If the overheating has been caused by *faulty lubrication*, it is probable that this is due to inattention to the lubricators.

Remarks as to Lubrication.—It should be ascertained from the makers how many drops per minute are required for the proper lubrication of the engine, and it must be remembered also that in cold weather when the oil is thick a different adjustment will be necessary from that found suitable in warm weather. It is most important that the lubrication should be regular, and with good oil, but not too much; for too much oil will spoil the sparking plugs, clog the valves, and interfere with the explosive mixture. For this reason the lubricators should always be carefully closed when stopping. If a Dubrulle type mechanical lubricator be used, examine the ball valves sometimes, and do not trust entirely to the sight feed. If a pressure type lubricator be used, see that the stopper is tight, for if the pressure from the exhaust leak, the lubrication will stop and in some cars the supply of petrol too.

It sometimes happens that an oil pipe or hole is stopped up and wants cleaning, or perhaps the plug at the bottom of the crank chamber has become unscrewed with the vibration and has dropped off, losing the oil in which the cranks should always dip. The proper amount of oil for each crank case is generally at least half a pint; an extra lubricator to the cylinders or base chamber should always be fitted, so that a little extra oil can be fed in by hand, if there be any doubt about the engine getting sufficient.

The following are additional causes of overheating. They are, however, of very rare occurrence :—

Cause 4.—Water may find its way into the cylinder through a faulty head joint or a porous casting.

Cause 5.—In some small engines if the throttle is kept full open continually, so as to admit too powerful a charge of gas, overheating will result.

Cause 6.—Finally, a thick incrustation on the walls of the water jacket, due to the use of bad water, will prevent the cooling

water from taking up the excess of heat from the cylinder; this can be removed by scraping.

Remarks on Overheating.—Note.—It may sometimes be that the radiating surface is insufficient in hot weather, or that the interior of the radiator is coated with deposit; in the latter case steam from a boiler should be blown through it for an hour or so.

How to tell when a Motor is Overheating.—The symptoms are:—

1. The driver can generally detect a slight smoke rising from the engine, and a smell of burnt paint and burnt oil.

2. A peculiar tapping sound becomes audible.

3. The engine will continue firing for a few revolutions after the current has been switched off or the burners extinguished.

4. Steam issues from the cooling water or the water is blown out of the overflow pipe.

What to do when the Motor Heats.—As soon as any of the above symptoms are noticed—

(1) The motor should be stopped at once.

(2) Paraffin should be copiously injected into the cylinders and the engine turned by hand to free the piston-rings.

(3) The parts should then be allowed to cool.

(4) Change the exhaust springs.

N.B.—Do not pour cold water into the cylinder jackets, for fear of cracking them, but rather pour into the tank so as to warm the water before it reaches the cylinders.

Dangers of a 'Seize.'—Overheating of the engine to this extent should be guarded against, for it is liable to cause scoring of the cylinder walls, or leakage of a cylinder or connecting rod, and may warp the cylinder-head joint (if there be one), which will necessitate re-making the faces—a tedious and difficult task. The exhaust-valve lifters may 'seize,' the excess of heat will also cause the valve-springs, piston-rings (and possibly the occupants of the car), to lose their temper; apart from the above no damaging effects are usual.

Precautions.—To enable the driver to verify the water cir-

culation a 'manometer' should be placed on the dashboard of every car to indicate the pressure of water, or a tap or float arrangement may be connected with the piping, so as to show whether the circulation is all right. During hard frost this is especially important, for should the circulation cease, the radiator, pump, or piping may be burst by the frost before the engine 'seizes.'

B. *Starvation of Carburator.*—A motor may, of course, stop from many other causes besides overheating—for instance, no petrol may reach the carburator. One of the following will probably account for this :—

Cause 1.—Petrol supply tap has turned itself off by vibration against tools, &c.

Cause 2.—No pressure to feed petrol (in the case of pressure-fed tanks).

Cause 3.—Supply pipe, filter or jet in carburator blocked with a piece of waste, asbestos, dirt, or deposit.

Cause 4.—If the tank is nearly empty, and a very steep hill is encountered, the carburator may be too high for the petrol to run into it ; the remedy is to pump air pressure into the tank.

Cause 5.—A union may be disconnected, pipe broken or plug under carburator dropped off, and you have lost all your petrol, or perhaps the tank has simply run dry. Remedy :—leave your friend to sleep on the car, take a list of petrol depôts, and make your way to the nearest town ; if yon cannot get any motor spirit, bring out some common benzoline of about ·700 gravity—and take a spare tin of petrol on the car next time.

C. *Carburator flooded.*—If, on the other hand, there appear to be too much petrol about, and it is running out of the carburator, the float needle is stuck or bent, or the float has punctured and petrol got inside it. In the latter case, take out the float, make a hole large enough to let out the petrol, and carefully solder up air-tight again.

D. If your burners (of a tube-ignition car) go out when you start the car, as is sometimes the case, it is due to the jerk of the car sending the petrol from the burners back along the supply pipe towards the tank. To obviate this, the tap should be opened as little as possible.

E. If the car stop from some mechanical cause, the reason may probably be found in the former section 'Motor will not start,' or in the chapters dealing with Transmission or Ignition. Most probably it will be due to :—

i. A broken valve.
ii. Broken or misplaced spring.
iii. Valve-gear not operating properly, or
iv. Something has lodged on the face of the valve, holding it open. I have known the cotter of an inlet valve and parts of sparking plugs sucked under the inlet valve, where they have stuck or gone into the cylinder and even through to the exhaust box at the back of the car.

2. MOTOR NEARLY STOPS AND THEN GOES ON AGAIN WITH FULL POWER

This is generally due to temporary starvation of the carburator. There is probably some water, oil, waste, dust, asbestos, dirt, or deposit of some sort lodging itself at the ingress of the spirit, which, however, frees itself intermittently. To avoid these troubles petrol should never be poured into the tank except through a funnel fitted with a very fine gauze strainer or a piece of muslin. I have several times known a little particle of matter dance about in the mixing chamber, and once in a way it would lodge on top of the spray-nipple for a time.

It should be remembered that air must always find an inlet to the tank in order that the petrol may flow out freely, and considerable difficulty has been caused by the tiny vent-hole which is generally in the stopper of the main tank becoming blocked up by some dirt or by an overcoat lying on it under the cushion. It may happen that air can get to it when you are starting up ; then when you sit down on the cushion the hole becomes air-tight and the engine gradually stops.

3. MOTOR WILL NOT 'PULL' WELL OR MISSES FIRE

The cause of this malady will probably lay under one of the following headings :—

Ignition.	Cooling.
Carburation.	Valves, or
Compression.	Governor.
Lubrication.	

Nothing is so annoying as to drive a motor which is continually missing fire or has a 'fit of the slows.' The fault is usually with the *ignition*—probably a sparking plug or trembler is broken or dirty, or a wire is loose, the battery exhausted, or the 'timing' is incorrect (see 'Ignition,' Chapter VIII.). In the case of tube ignition, perhaps the platinum tubes are not hot enough, or are dirty inside or outside, or the passages leading to them are clogged. When exhaust pressure is adopted for feeding the burners with petrol, the pressure-valve sometimes refuses to act and lets the pressure out. Remedy for this :—Grind the little valve or change the spring, and see that its lift is just one millimetre ; but we are again trespassing into the province of Chapter VIII.

If the root of the difficulty be elsewhere, probably the *carburation* is not good :—

The proportions of air and gas are not well adjusted, or they may be incorrect for one of the following reasons : the petrol cannot obtain free access to the carburator (see 'Motor nearly stops'); too much petrol is entering the carburator (see 'Carburator flooded') ; the gauze through which on some cars the air is sucked is blocked with dust, or the gauze which is sometimes fitted into the induction pipe is dirty, or that fitted between the exhaust and the pressure valve (in cases where a branch of the exhaust is utilised to maintain pressure in the petrol or lubricating tanks) is foul.

A pipe-joint is loose or has a hidden crack through which an excess of air enters, or the petrol is stale.

See also 'Carburation,' pp. 169 and 170.

If the *compression* is faulty, see 'Motor will not start.'

There may be insufficient *lubrication*, causing heat, or perhaps too much lubricating oil is used, causing (i) valves to

stick ; (ii) a deposit on the sparking plugs ; and (iii) an unhealthy charge in the cylinder. Excess of oil reveals itself in the form of smoke issuing from the exhaust.

Cooling.—If the water circulation ceases or is faulty, it should be remedied at once to guard against the dangers of a 'seize' (see 'Water circulation' and remarks on 'Overheating,' pp. 176–177).

If one cylinder misses fire *regularly* and the fault is not one of the above, it is probable that

i. The exhaust or induction *valve* has stuck open owing to the spindle being dirty, or through a broken part, a displaced spring, or something lodging under the face of the valve.

ii. The jet for supplying that cylinder with petrol vapour is blocked.

If, however, the misfiring be *irregular*, and none of the defects aforementioned be found, we must look to less common sources for the difficulty.

How to find which Cylinder Misses.—Endeavour first to ascertain which cylinder is the culprit. One method of doing this is to place your hand on each exhaust pipe while the engine is running. You will then get a bad burn from every one except that belonging to the faulty cylinder. A more convenient way—if a suitable form of electric ignition be fitted—is to stop the working of three out of four of the induction coils, changing about until you find the one that is at fault. It may be, however, that your engine has only one cylinder, or that *all* the cylinders miss occasionally.

Let us take the remaining possible causes of the difficulty.

1. Be sure that the governing gear is working properly, and that the governor does not cut out one cylinder when it ought not, or that the throttle has not jammed.

2. The induction valve (automatic) may have worn, and opens too much.

3. Exhaust or induction valve lifters worn and do not lift enough.

4 (*rare*). They have expanded through being overheated, and open too much.

5. The exhaust or induction valve springs are not strong enough to close quickly, and an exhaust valve may sometimes be opening on the suction stroke.

6 (*rare*). In some engines the mushroom-shaped object called the diffuser, which is part of the small disc screwed into the top of the carburator, may be too near or too far from the jet of petrol.

7. Or the size of the nipple through which the jet is sucked is too large or too small. It is seldom that this should be touched, and its adjústment must be made with extreme delicacy, by the aid of a watchmaker's brooch-needle. It is always best to make any experiments on a spare nipple, and not to touch the one that is in use, so that if unsuccessful you may put back the old one, otherwise the last state of your carburation may be considerably worse than the first.

8. Trouble will sometimes arise through the carburator freezing, even in warm weather. The remedy is to fit a pipe to convey to it air heated by the exhaust or the burners. Conversely, when the carburator is heated by a by-pass from the water circulation, too much hot water passing through may overheat the carburator.

There are still a few, but extremely improbable, causes for irregular firing :—

9. There may be too much play through wear in the cogs of the valve gear or ignition gear. The remedy is to advance one tooth.

10. The cog wheels that operate the valve motion or ignition gear may have been put together wrongly by a repairer.

N.B.—Always make your own marks when taking these wheels apart, for the existing marks may not necessarily be correct. The makers not infrequently find a better position for the teeth to engage in after one set of marks has already been made.

11. It has also happened that the key or feather by which a gear wheel of the ignition or valve mechanism is keyed on to its shaft has sheered, and the wheel has moved round on its spindle, causing firing to take place at the wrong instant and very erratic behaviour in consequence.

12. For reasons previously explained, if water can find its way into the cylinder, 'misfiring' will result.

Finally, it should be noted that an engine which is 'missing fire' and 'pulling' badly at the start will often run perfectly

well after a few miles when it warms up, the reason being that the heat assists the carburation, makes the ignition more certain, and increases the compression, especially when there is a slight leak which will 'take up' on expansion of the metal.

4. ENGINE RACES, *i.e.* GOVERNOR WILL NOT WORK

Evidently something wrong with the governing gear. What?

1. One of the springs which control the balls of the governor has come off.

2. The throttle has jammed in the carburator and will not shut, or has become disconnected from the spindle.

3. Some part of the governing gear is stiff or has broken.

The following remarks refer to the older system of governing—by keeping the exhaust valves closed—in which troubles were much more frequent than with the modern system of controlling the feed of explosive gas to the cylinders.

4. The cam, which by means of a small object resembling a hammer, throws the exhaust-valve lifters out of action, is generally keyed to its shaft by a small screw; if this works out, as it sometimes does, the cam will move about where it likes, and lead to the fault in question.

5. Similarly if the 'hammer' gets loose or is worn, the same result will follow.

6. The governor is often arranged to cut out one or two cylinders before the rest; if much wear has taken place in this mechanism the trouble may arise.

There are also springs whose function it is to bring back the exhaust lifters into action after they have been 'cut out' by the governor. If this mechanism has been roughly fitted or has had much wear, I have often found that the ends of these springs should be slipped off their knobs for the engine to govern properly; and that if they are in place one cylinder may refuse to cut out at all.

7. Of course if any of the delicate spindles, &c., connected with the governing mechanism be strained in any way, or are allowed to get dry for want of oil, the same trouble may be expected.

If the governor goes wrong at an awkward moment in the

traffic, and the engine begins to race, it may be controlled by switching off and on, or retarding ignition, admitting an excess of air, or the exhaust-valve lifters may be thrown out by hand.

5. UNUSUAL NOISES

Regular.—If an unusual but regular *puffing* noise (external) be heard, which keeps time with the engine without apparently affecting its running, it is clear that an exhaust joint has given out somewhere between the exhaust valve and silencer. If the rupture be near the engine, the exhaust gases may slightly interfere with the carburation and the burners (with tube ignition), but otherwise no harm will be done to the motor, though the noise may frighten passing horses.

A regular but unusual *tapping* or *knocking* in the engine indicates

i. Something loose or broken, as, for instance, a loose connecting-rod end, a loose gudgeon pin, connecting rods not at right angles to crank shaft, or loose fly-wheel.
ii. Too much advance in ignition, or
iii. Engine about to seize through overheating.

If a *squeak* be heard anywhere careful attention should be paid to it, otherwise harm may be done. A slight squeak is often very difficult to locate, and turns out sometimes to be perfectly harmless; a squeak has been traced to the rubbing of the bonnet against something inside it, to the shaking of the radiator, vibration of lamps, and such like causes, which, though trivial when found, are sources of anxiety to a careful motorist.

I have had a distinct whistling sound produced by the rapid suction of air through a brass tap at each revolution of the engine. This took a long time to discover. A slight leak of compression will also sometimes produce a squeak at each explosion.

Irregular.—Popping Noises in the Carburator or Induction Pipes.—These are minute and harmless explosions caused by :—

i. Induction valves opening too much, or
ii. Sticking, or
iii. Their springs being too weak.
iv. Cold ignition tubes.
v. Retarding the ignition too much, or
vi. Bad carburation.

Bursting Noises (irregular) coming from the Engine.

i. These indicate :—Burst joint at valve cover, sparking plug, or ignition tube. Spare washers specially made must always be carried to rectify these.

ii. A platinum tube may have burst. Spare ones should always be carried.

What to do if Ignition Tube burst and you have no spare one.—If you have no spare one, the hole of the old one should be closed up as much as possible with a small hammer, then replace the tube with the hole in such a position as not to blow out the burner or its neighbour. If you can keep the burners alight progress can thus be made. Failing this, the faulty tube or the hole leading to it must be blocked up, and the car run home on the remaining cylinder or cylinders.

iii. *Loud Report in Exhaust.*—This is due to several unexploded charges having collected in the silencer, and being ignited by the incandescent products of the next fired charge ; switching the electric ignition off and on will often produce this, so may a sudden retarding of ignition, or a semi-cold platinum tube.

There is no danger in these explosions—startling as they seem—beyond the risk of splitting the exhaust box or pipe and alarming a timid passer-by.

RÉSUMÉ

It will now be seen that troubles may arise from any of the six following sources :—

Ignition	Lubrication
Carburation	Cooling, and
Compression	Working parts.

I have tried to classify all possible troubles according to their symptoms, so as to make it easy for the novice quickly to locate the root of evil and rectify the fault.

CONCLUDING ADVICE AND REMARKS

If your motor works well, don't tinker with it, although it may never seem fast enough. Many troubles arise from interference and undue curiosity.

Remember that petrol is a highly volatile and inflammable liquid ; its vapour is equally dangerous and will generally, it should be remembered, fall to the ground rather than rise, and may thus accumulate at the bottom of an inspection pit.

Make sure that all petrol connections and unions are taut.

If you have a flare-up, immediately close the supply cocks or let off the pressure, take off bonnet to save the paint, and smother the flames, or let them burn out. Water should only be thrown to save woodwork. Sand or clay is good for extinguishing petrol flames, or best of all, one or two syphons of soda water. A chemical extinguisher in good order should always be kept in the motor house.

Don't pour out petrol near a naked light ; it is prudent to extinguish the burners (if any) when filling the tanks of the car.

Don't spill the petrol over your clothes and then strike a match to light your pipe.

Don't go out even for a short run without complete equipment of tools, spare parts, petrol, pump, and repair outfit, etc., or you may be back late.

Don't let a willing ostler fill up your petrol tank with water.

Don't leave the water in your car on a frosty night, except with 20 per cent. of glycerine in it.

Don't start away with your break hard on and then wonder why the motor is not pulling.

Don't pedal your motor-cycle for half an hour before remembering the plug switch, unless the doctor recommend it.

Don't let the starting handle fly off and hit you on the nose, and

Don't trouble to turn on the petrol tap if there be no petrol in the tank.

CHAPTER X

THE PETROL CAR

I. TRANSMISSION

BY HENRY STURMEY, F.R.P.S., HON. M.C.E.I.

THIS is a wide subject, and to be properly and thoroughly dealt with requires much more space than has been placed at my disposal, so that I shall simply endeavour to deal broadly with the principles of the best known types. Next to the engine itself the construction of the transmission gear is the most important thing about an autocar; for as this portion of the machine is the medium through which the power is conveyed from the engine to the wheels, it does not require an intimate knowledge of mechanics to perceive that bad design and undue friction here may make a very material difference in the running and speed of the car. As a matter of fact the whole power of the engine is never available for the work of turning the wheels of the car, a certain portion of it always being absorbed in the work of driving the gear; indeed, it is not too much to say that in some instances—as has indeed been proved by actual tests—fully one half of the power developed by the engine is thus lost between the motor and the wheels. Consequently high efficiency in the transmission arrangements will mean greater economy in work, as well as better hill-climbing and speed results from the same engine, than would have been the case had a more faulty system been adopted. Broadly speaking, it may be said that the old adage 'simplicity is a virtue' holds particularly good in this connection, and it may be taken as an axiom that—all other things being equal—the simpler the gear the better and more efficient will it be.

That being so, it may not unnaturally be asked why the simplest method is not always used. If it were only the matter of conveyance of the power from the motor to the road wheels doubtless this would be done; but where the petrol or internal combustion motor is used another matter has to be provided for, and that is the variation of the ratio of engine speed to wheel speed; for where ample power is not used and there is little flexibility in the engine, unless the speed rate of the motor can be maintained, it will stop, so that 'variable gearing' has to be adopted and the power sent through this to the wheels. This implies that the means of transmission may be so altered at will that whereas when on level ground the engine may make, say, only two revolutions to each one of the road wheels, for hilly or heavy work it may make, say, four, six or eight, and so, whilst the car travels slower, the engine speed may remain the same. Where steam engines are used this is not usually required, as the steam engine obtains more power for heavier work by the use of more steam, whilst the gradual increase of power in petrol engines and their greater flexibility obtained by the enjoyment of throttle control and modern carburetters is rendering the use of a large number of speed variations even with these more or less superfluous.

Now the simplest method possible would be the driving of the road wheels or wheel direct by the piston-rods of the engine, a plan only possible where a very small wheel is used, and consequently inadaptable readily to autocar construction. Next to this comes the use of gear wheels—'cog' wheels—as employed upon tricycles and some light forms of car where the motor is set close to the axle. In these we have one gear wheel fixed to the shaft of the motor, gearing into a similar one upon the axle. And here we may halt for a moment to consider the action of gear wheels. As will be seen by fig. 1, we have two wheels, the edges of which are cut into a number of equal-sized teeth, and these wheels are so fixed in relation to each other that the two sets of teeth mesh or interlock with each other. Now it will be seen that any movement of one will be imparted to the other through the teeth, but *in an opposite*

direction—thus if wheel A revolves to the right, wheel B will turn to the left, and *vice versa*. There is also another peculiarity about these wheels. It will be noticed that they are of different sizes. The result is that if wheel A is the first to receive the power, one turn of the wheel will not cause wheel B to make a complete turn, whilst, conversely, wheel B being the larger of the two, will, if revolved, cause wheel A to turn more than once. Just what their actual relation of movement to each other may be, is determined actually by their respective diameters and, for ease of calculation, by the number of teeth they respectively contain. Thus if wheel A contains 20 teeth and wheel B 50, it will take $2\frac{1}{2}$ turns of A to revolve B once,

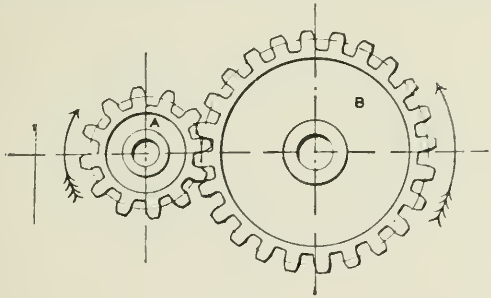


Fig. 1

whilst one revolution of B as the driver would cause A to go round $2\frac{1}{2}$ times. It will thus be seen that by varying the size of the different gear wheels used, the ratio between engine and road wheels can be varied. In an arrangement employing this simple form of transmission only, the engine and axle must be set close together, and we only have the friction in the bearings of the engine and road wheels to be overcome, together with that caused by the teeth of the gear wheels as they engage with and push each other around. When, however, it is found desirable that the engine should be separated from the road wheels, some other form of transmission becomes necessary, and other means have to be adopted ; and the simplest and

cheapest in point of manufacture, though not the most efficient, is shown in fig. 2, where we have, as before, two different-sized wheels, one connected with the motor-shaft and the other with the driving-axle of the road wheels. Instead, however, of their faces or edges being cut into teeth, they are smooth, and the two are connected by a flat leather belt. Here, as before, the wheels will be revolved in relation to each other according to their respective diameters, but, as shown by the arrows, they will both revolve the same way. This is advantageous, for every time the direction of power application is changed some loss takes place. By crossing the belt, however, the pulleys or belt wheels may, if desired, be made to revolve in opposite directions. On the other hand, the

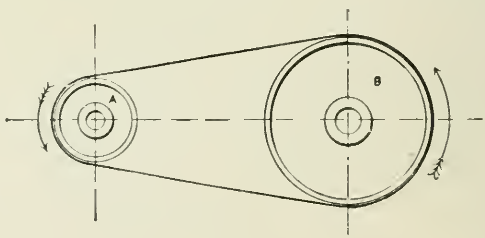


Fig. 2

connection, not being positive, but depending upon the tightness or grip of the belt, there is more or less slip, so that the ratio of rotation is not constantly the same, and as, in order to obtain sufficient grip for heavy work, the belt has to be tightly stretched, the two wheels at either end are forcibly pulled towards each other, and some extra friction, through pressure, produced in the bearings. The slip of the belt, however, is not altogether a disadvantage, as it absorbs the shock of the engine and prevents damage from that cause, whilst there being no metallic parts in contact, belt driving is quite silent in running, and the same cannot be said of gearing, for this is very noisy, which is not only an annoyance but an eventual source of trouble and expense, as noise means wear.

Another form of transmission may be said to combine the principal features of both the previous systems, and that is chain driving. Here, as before (see fig. 3), we have two wheels or pulleys connected by a flexible band, but the pulleys are not smooth as before. Their faces are cut into teeth suitably shaped to engage the links of a metallic chain which takes the place of the belt. As with belt driving, the driven pulley or chain wheel, B, revolves in the same direction as the driving pulley or sprocket A. This method possesses the feature of positive driving belonging to the gear wheels, and whilst it has none of the slip of the belt there is some elasticity in the chain, which helps to take up driving

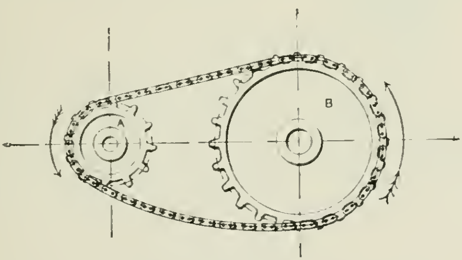


Fig. 3

shocks and secures silent running. The extra friction on the bearings necessitated by belt driving is avoided, as the chain may be run fairly slack and the lower side hang loosely as shown in the diagram, the chain automatically tightening itself at the top as the different links are taken up by the teeth.

Where two chains are used there is bound to be some rattle, owing to the two not being able to run exactly together, so that whilst one is tight the other is slack; but a single chain is—like that of a bicycle, which it much resembles—practically silent. Wet, mud, and dust will also cause chains to 'grind' and become noisy, and therefore they should be so placed that they will not readily meet with these, and if possible enclosed in a cover or gear-case; and the

same may be said of both gearing and belts, for both are better servants in every way if so protected. The chains used are similar in construction to those fitted upon bicycles, and are either of the 'block' or 'roller' variety. In the former (see fig. 4) the side links, C, C, C, are connected by solid blocks of

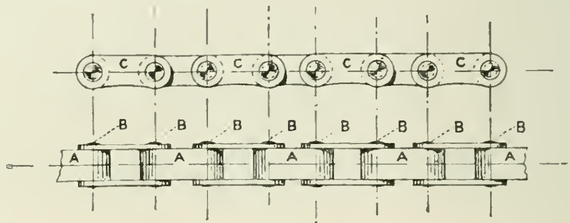


Fig. 4

metal, A, A, A, through the ends of which the connecting pins, B, B, B, pass, these pins turning slightly in their bearings in the blocks as they pass round the chain wheels. In the latter—shown in fig. 5—the blocks are replaced by connecting plates A, A A, and upon the cylindrical separators connecting them

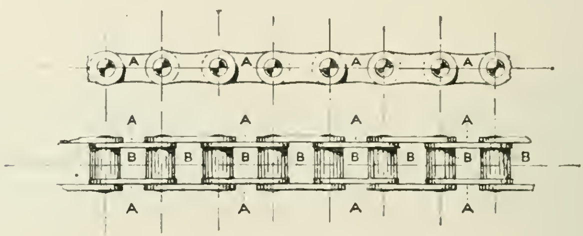


Fig. 5

small cylinders or rollers, B, B, B, are fitted, which roll into and out of the chain-wheel teeth as they come round. As a rule, unless some special provision be made for thorough lubrication of the connecting pins of the blocks, roller chains are usually found to run with the greater smoothness and quietude. In addition to these methods we have yet another which has been

very largely used lately, especially upon light cars, and that is the use of bevel gearing and a connecting-rod, with universal joint to secure flexibility. This system is shown in figs. 6, 7,

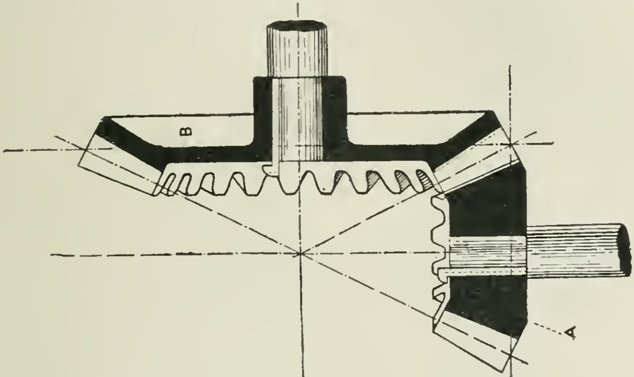


Fig. 7

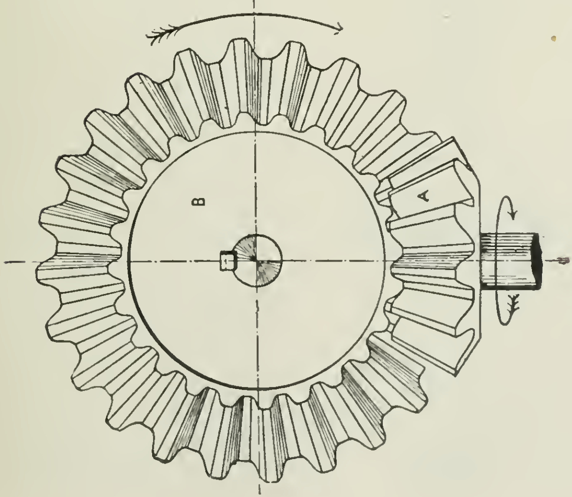


Fig. 6

8, and 9. Here we have a rod or shaft with a gear wheel at one end. This wheel, however, is conical or bevelled (see A, figs. 6 and 7), and the teeth are wider on the outside than upon the inside. It engages with a wheel B upon the axle or other portion of the machinery, which is also bevelled, and bears corresponding teeth. It will be seen that whereas in each of the three methods first described the axes of the motor shaft and wheel axle are parallel, in this case they are at right angles, the forward end of the shaft being united to the motor shaft by a clutch or other suitable means, and rotated by it. In action these bevelled wheels are similar to the gear wheels first described, but instead of revolving lightly on their bearings and pushing round the teeth of the opposite wheel as they come in contact, their shape causes a strong repelling action also to take place, the tendency of the bevelled faces of the gear wheels being to force themselves apart, which throws a considerable binding

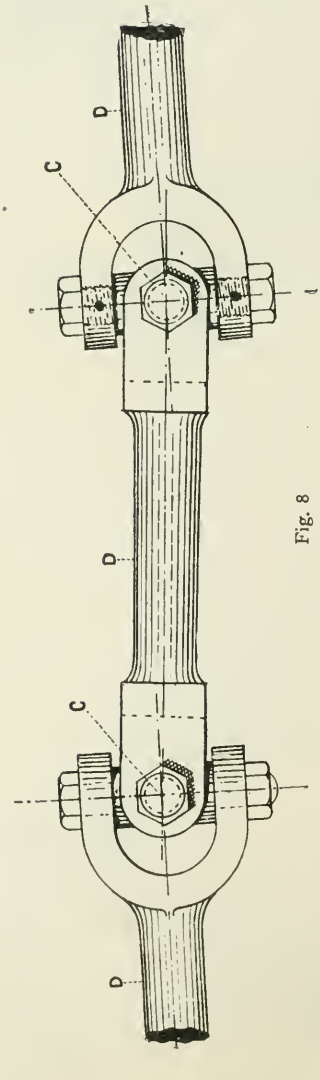


Fig. 8

or cross strain upon the bearings. The power, too, is deflected at right angles, which is another source of loss.

In order to permit of the free vertical movement of the wheels under the springs, two universal or 'Cardan' joints, C, C, are fitted within the length of the shaft D (see fig. 8). These consist of two jaws set at right angles, with their ends connected to and rocking upon the extremities of a right-angled connecting piece. This allows movement in all directions, and the shaft accommodates itself to the conditions of the drive. This method is chiefly used because of its lightness, cheapness of construction, convenience, and neatness.

Another plan, employed however only by one or two firms, substitutes for the bevel gearing what is known as skew or screw gearing, a very smooth and silent drive without the spreading or bursting action of the bevels, the end of the driving shaft being fitted with a screw which drives a series of teeth cut diagonally around the circumference of the driven wheel.

I have said above that the forward end of the propeller or arbor shaft is connected to the engine shaft by a clutch, and this brings me to another almost universal and very important portion of the transmission gear. In belt-driven cars a clutch is rarely used, the slip of the belt being relied on to give the necessary immunity from shock, but in cars which are driven by chains, arbor-shaft, or gearing, a clutch is a necessity, otherwise the sudden application of power would strip the teeth of the gear, break the chain, or cause other damage, and something is needed to ease the shock. Clutches may be 'positive' or frictional, but friction clutches only are referred to above. These commonly take the form of a truncated cone or inclined surface so arranged upon that portion of the transmission which carries the gearing or other connection with the wheels that, by sliding it slightly forward, it enters a socket having an internally coned surface into which it exactly fits. Sometimes one of the surfaces is covered with leather, but otherwise both are metallic and a strong spring is usually

fitted at the back of the cone by which it is forced into its socket. In a great many of the most popular types of car the hollowed socket for the cone is formed in the centre of the fly-wheel of the engine, which thus drives the mechanism through the clutch. The spring has a certain tension, and the friction between the two surfaces when pressed together by the spring is sufficient to drive the car without slip under all ordinary circumstances; but at starting, when the power is applied suddenly to an inert mass, a much greater amount of friction is engendered, and the cone slips slightly in

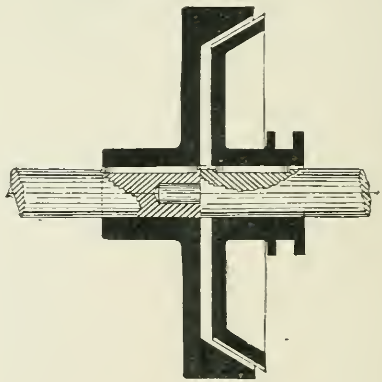


Fig. 9

its socket, thus saving the gearing and the machinery from jar and shock, and enabling the power to be applied gently. The construction of a clutch of this character is shown at fig. 9.

Occasionally also two friction clutches acting in opposite directions are used to connect or disconnect alternately some portion of the gear, in which case they are not spring held, but are moved from side to side by a lever—thus, in fig. 10 we have two gear wheels, which may be of different sizes, running on one shaft with a double clutch between them. By moving the clutch over to the left, wheel A is held fast to and driven by the shaft upon which the clutch slides, whilst by moving it

in the opposite direction, wheel A is freed, and wheel B held fast, and if the clutch be held stationary at a point midway

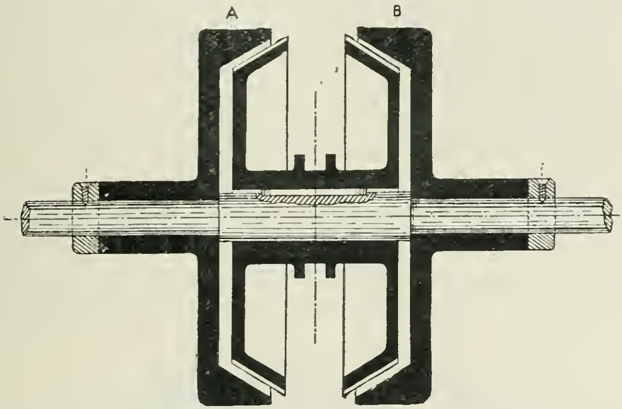


Fig. 10

between the two, both wheels are free and neither is driven. In another form of clutch, connection is made by expanding friction rings on the inner faces of drums, fixed to the parts

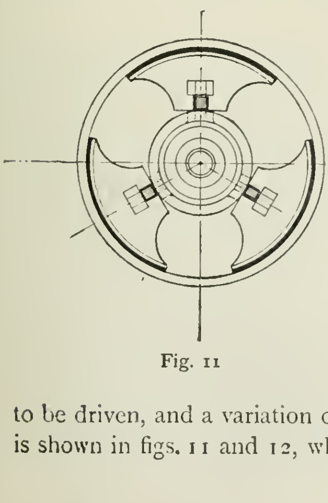


Fig. 11

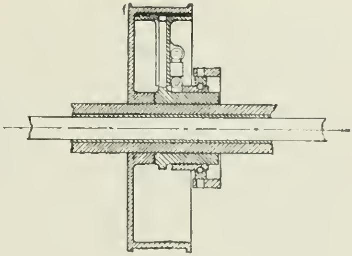


Fig. 12

to be driven, and a variation of this form of expanding clutch is shown in figs. 11 and 12, where a hollow drum is connected

to the engine while the driven (concentric) shaft carries a sleeve furnished with means whereby it may be moved along the shaft longitudinally. To this sleeve are jointed short arms or toggles, which are interposed between the sleeve and a series of leather-faced discs; the outer surfaces form arcs of a circle corresponding with that formed by the interior of the drum. When it is required to connect the shaft with the engine the sleeve is moved towards the latter, a movement which brings the toggle arms more nearly underneath and in line with the clutch discs, which, as will be seen by the illustration, are forced outwards into tight contact with the inner face of the drum. Very careful adjustment of a clutch of this character is requisite to ensure proper working, and this is readily done

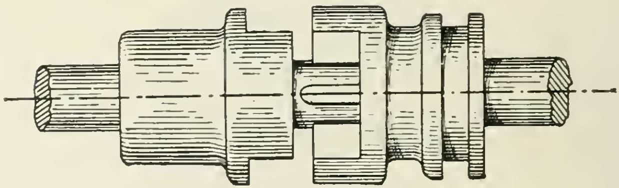


Fig. 13

by screwing in or out and so lengthening or shortening the toggles.

Positive clutches are used temporarily to connect various portions of the gear from time to time, as may be required, and these take the form of notches or projections upon a sliding ring or collar or other part of the machinery which, when moved along a shaft, can engage with or slip into corresponding notches or projections on the part with which it is desired to make connection. In this case the connection is sudden, and from a position of absolute rest the part put into gear by the clutch is instantly moved forward at the same velocity as the rest of the machinery the moment the clutch teeth slip into their places. Figs. 13, 14, and 15 show a common form of positive clutch. This form of clutch, it

may be noted, is—or should be—always used in conjunction with a clutch of the friction order—i.e. whilst individual portions of gear may be connected with and disconnected from each other by the use of positive clutches, a friction clutch always connects the engine with the machinery so that the shock is taken up there. The teeth, notches, or projections of positive clutches require to be very carefully and accurately cut and properly hardened, for if they are not they are very apt to be chipped and to wear by the action of engagement. Rough edges denote chipping, and rounded edges much out of shape indicate wear. When this is the case the gear becomes very noisy in action, and much movement of the parts is noticeable when the actuating lever is moved to and fro. In these circum-

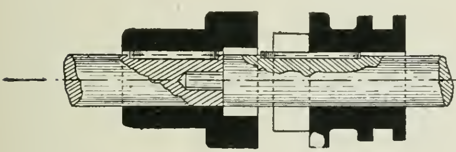


Fig. 14.—Section

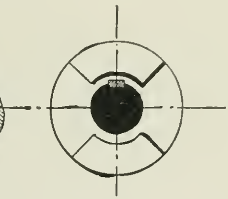


Fig. 15.—End Section

stances they will require facing or re-cutting, and this should be done at once when such a condition of things is discovered, or the condition of the parts will rapidly go from bad to worse. These latter remarks also apply to the teeth of gear wheels.

Having now briefly considered the principal details of simple transmission, we pass on to the means whereby the ratio of the gears may be altered as required by the road conditions, and in so doing have to combine the speed-varying gear with the transmission gear proper; and the best way to do this perhaps will be to illustrate the principles employed by reference to examples of the various systems.

In the first place, belt-driving cars have usually two belts running on pulleys of different sizes, so that shifting the belts causes either one or the other of the two speed ratios to be

used. The belt system generally drives the car through chains, so that, whilst belt gearing is used for the speed variation, the transmission to the wheels is by chains: the engine through the belts drives a countershaft the ends of which are provided with sprocket wheels connecting by chains with the driving wheels.

In using belts care must be taken in shifting the belts to throw off one before attempting to put the other into operation, or broken belts and perhaps worse accidents may result. Belt driving is wonderfully smooth and quiet in action, and commendable from this point of view, but unless very carefully looked after liable to give trouble by undue slipping and breaking. When carefully attended to and intelligently applied, belts can be made very satisfactory. Mr. Lyons Sampson, for instance, tells me he had one pair of belts in use for over a year, and had no trouble with them; but then Mr. Sampson has given the subject very careful consideration, and sees that they get the little care they need. For instance he runs his belts flat instead of crossed, which by not bending them so much puts less strain on the fibres. He uses the belt, too, with the skin side to the pulleys, protects them as much as possible from wet, and uses loose pulleys of the same diameter as the fast ones instead of slightly smaller, as is usual. This, whilst keeping the strain on during use, does not necessitate the belt being pushed up over the sharp edge of the fast pulley every time it is put into action. Mr. Sampson is also careful to take the belts off entirely when the car is not in use.

Mr. R. W. Buttemer, another successful belt-user, recommends using lightly tanned leather for the belts instead of raw hide, which is preferred by some, and before putting on a new belt hangs a 1-cwt. weight on it for a day or two to take the stretch out of it, following this by a soaking in castor oil.

If more than two gear ratios are required, a third or fourth belt may be used, or some other form of gearing employed, whilst reversing is usually effected by using a crossed belt. A 'Crypto,' 'epicyclic,' or 'Sun and Planet' gear is arranged as shown in

fig. 16, and consists of two gear wheels, a small or Sun wheel A, having external teeth, and a large one B arranged on the outside of it with internal teeth, whilst in the space between the two one or more pinions or planet gear wheels, C, C, just large enough to fill the space between them and cut with teeth to correspond with those on the two gear wheels, are placed, these pinions being mounted on pins carried by a ring or disc D, which may or may not be supported by arms, E, E, E, E, from a centre as shown. We thus have three members, the outside gear wheel, the inside gear wheel, and the pinions, and the whole makes a most accommodating arrangement; for if the inner wheel A be held fast and the ring D, carrying the

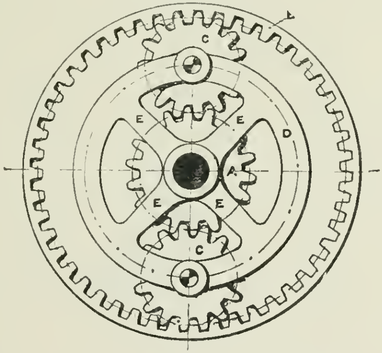


Fig. 16

pinions, revolved, the outer wheel B is caused to revolve at a faster rate than the ring, whilst if the outer wheel be held the inner wheel will also be driven at a faster speed, but in different ratios. On the other hand, if either the outer or inner wheel be held and the other driven, the ring or disc D, carrying the pinions, will be caused to revolve at two several lower rates of rotation; whilst if, in its turn, the pinion-ring is held and either of the wheels driven, the other wheel will be rotated at a different rate of speed, but in *the opposite direction*, and so a reversing action obtained, and by locking any two members together the whole contrivance is held rigid and revolves as a

solid wheel. By connecting any one member of a gear of this character with the engine shafting, and another with the wheels, and locking the third to the frame of the car, a great variety of adaptations can be made to meet special needs, this arrangement having the advantage of neatness and compactness, and having all the gear wheels in constant engagement with each other all the time; whilst when arranged to run with the gear locked or 'solid' there is no gearing at work and no loss at all from gear friction.

A gear of this character is used upon the Duryea, which has probably the simplest and most truly 'direct' transmission system of any, and is quoted as the most striking example not only of direct chain transmission, but of epicyclic gear. In this the Crypto is carried on an extension of the engine-shaft, and for ordinary use the intermediate and outer members are locked together by a friction clutch and catch bolts, the whole revolving solid, whilst a single chain carries the power from a sprocket on the gear shafts direct to the differential on the axle of the driving wheels; thus under all ordinary running conditions there is only the friction of the direct chain drive from engine to wheels. All intermediate speeds are obtained by varying the speed rate of the engine, which in this case possesses great flexibility and power, and will take the car up a 1 in 10 grade without change of gear. When steeper gradients than this have to be tackled a brake holds the outer member of the Crypto, which is driven by the inner wheel, and a 66 per cent. speed reduction of the sprocket—which is connected with the pinion-ring—obtained, whilst for reversing, a band brake is in turn applied to the pinion-ring, which is thus held to the frame and the action reversed, the pressure of the brake band withdrawing the connecting bolts and so rendering this possible. The general arrangement of the gear on this car is shown in fig. 17, where A represents the engine, B the fly-wheel, C the Crypto tucked inside it, D the outer bearing of the gearing, H the driving sprocket, I the chain, and J the differential on the driving axle.

The large majority of cars to-day, especially those of the heavier and more expensive class—such as Daimlers, Napiers, Panhards, &c.—are fitted with wheel-gearing and chain transmission, and in these, although the constructional details may vary with different makers, the principles and general system are the same. In the illustrations figs.

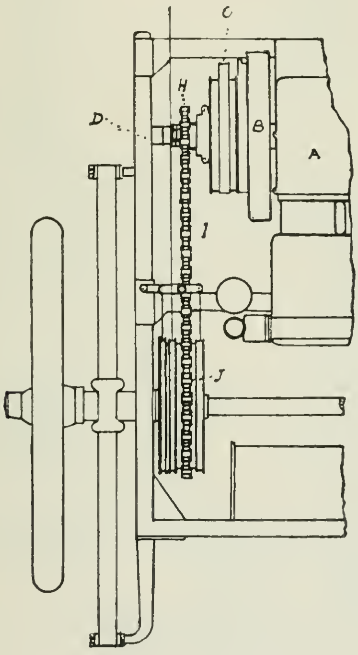


Fig. 17.—Duryea Transmission Gear

18 and 19 I have taken the transmission system of the 14 h.-p. Daimler to illustrate the type. This arrangement gives three speeds and a reverse. Others are more frequently arranged to give four speeds, but the system is the same. Fig. 18 shows the arrangement looking down from the top and fig. 19 is a sectional drawing of the gear

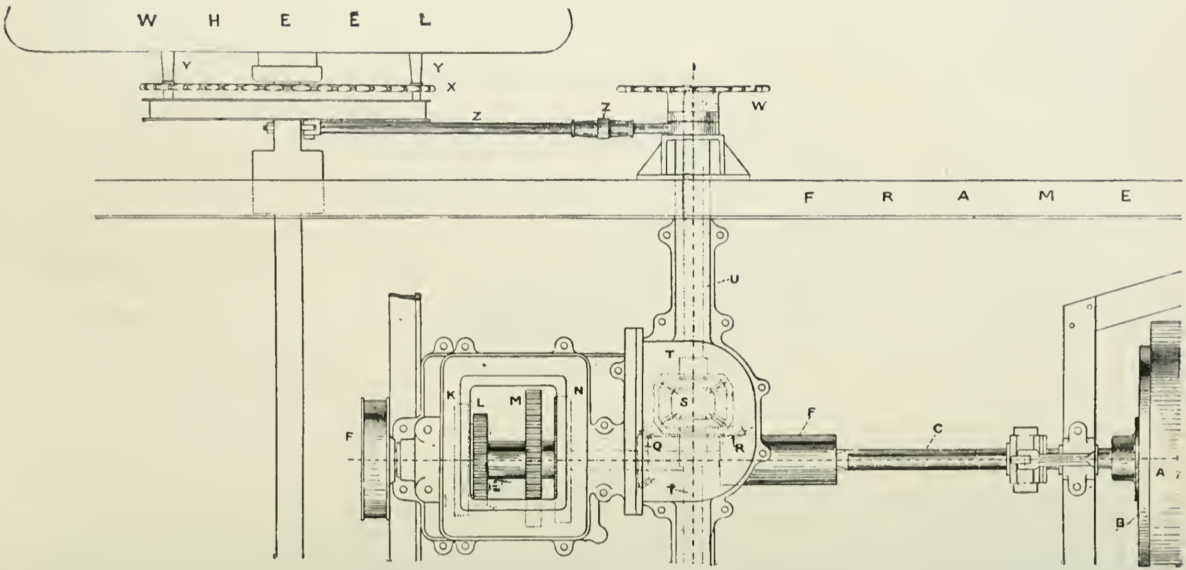


Fig. 18.—Daimler Co.'s Transmission Gear. Plan

looked at sideways. Here A represents the fly-wheel of the motor, and B the clutch working into its face. The clutch drives the shaft C, and can be drawn back and so disconnected from the engine by pressure on a foot lever coupled up to the end of the lever D shown in fig. 19, the end of this lever also being attached to a strong adjustable spiral spring (not shown) which keeps the clutch engaged on the fly-wheel, allowance for this drawing back being made as shown at E, the shaft being in two pieces, the ends connected by the slide-block F. The driving-shaft runs back down the centre of the car, and carries a series of three different-sized gear wheels, G, H, and I, so arranged that whilst they are taken round with the shaft, they are free to slide to and fro upon it

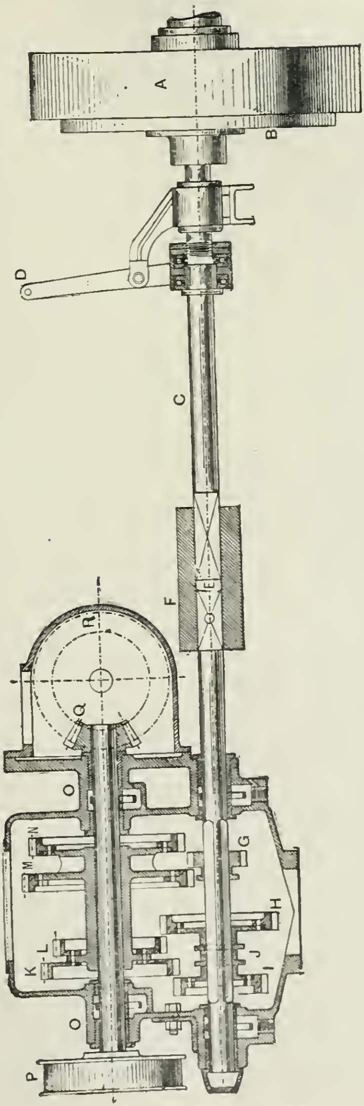


Fig. 19.—Daimler Transmission Gear. Sectional elevation

when moved by a hand lever at the side of the car, which is connected up with the slide collar J (fig. 19). Thus all three gear wheels revolve at the same speed as the engine. Immediately above this shaft, as shown in fig. 19, is a second shaft arranged parallel to it. This carries upon it the four gear wheels, K, L, M, and N, all of which are fixed to it and revolve with, but do not slide upon it. This second shaft and its attached gear wheels are contained in the same metal gear-case in which the other gear wheels are enclosed, and which can be filled with lubricating oil. It runs in bearings O, O, in the walls of the case, through which it projects at either end. The rear end carries a drum P, around which a band brake is applied, and the forward end carries a bevelled pinion Q, which gears with and drives a bevel wheel R.

This wheel is attached to the differential or 'balance gear' S (fig. 18)—the function of a differential is dealt with in another chapter—connecting the two halves of a cross countershaft T, which runs in long bearings U, forming a cross support to the frame. The ends of the cross shaft are furnished with chain sprockets W, each carrying a chain which connects with and drives one of the driving wheels through the medium of a chain wheel X, which is bolted to the spokes by the bolts Y. Any stretch in the chains may be taken up by turning the nuts Z on the radius rods Z Z, the purpose of which is to maintain and adjust the proper distance between the countershaft and the wheel axles, and so secure the proper tension on the chains. In making this adjustment, care should be taken to see that the two rods are adjusted equally, or the chain wheels and sprockets will be thrown out of line and the chains may come off or break, besides putting much strain on the bearings and causing considerable additional friction. By putting on different-sized sprockets on the ends of the countershaft the ratio between the revolutions of engine and road wheels, so far as the top speed is concerned, may be varied to suit requirements, and by shifting the gear wheels G, H, and I so that they engage with either K, L, or M, this speed may be maintained or reductions made from it. Thus it will be seen that the different-sized

gear wheels are arranged on their respective shafts at such intervals that when one pair are in gear, the others are out of gear.

In the gear as shown, H, the largest wheel on the driving shaft is arranged to engage with L, the smallest on the driven shaft, the speed of which is, when these two wheels are in gear, increased; I, next in size on the lower shaft, gears with K, which is larger in diameter than I, so that when these two are engaged, the speed of the top shaft is less than that of the bottom one. Again, when G, the smallest of the three on the driving shaft, is in gear with M, the largest on the driven one, the speed of the latter is still further reduced. By moving this wheel G to the left it just clears wheel N on the upper shaft, and by further movement in this direction is brought into engagement with a third or intermediate wheel, not shown in the drawing, which is in engagement with N; and this, by conveying the power through the three wheels, causes N to revolve in the opposite direction to that taken by the other wheels on the top shaft, and thus a reversing action is obtained, and the driving wheels are impelled backwards instead of forwards. This shifting of the gear is effected by sliding the bottom series of gears in either direction as required, bringing the teeth of the two sets of wheels into juxtaposition and pressing the one against the other, till they slide into each other. This is an operation requiring considerable care, as both sets of wheels are revolving at a high rate of speed, one propelled by the motor and the other by the travelling car, and if they were forcibly brought together the teeth would be chipped or even broken off bodily, so that in making the change great care is necessary. The lever must be moved gently, whilst at the same time the foot must be pressed on the lever of the clutch, which is thus disconnected from the motor and the power of propulsion thus removed from the driving shaft whilst the change is being made. When putting a lower gear into operation, as is necessary when climbing a hill, the speed of the car should be allowed to fall to as nearly as possible the calculated speed of

the reduced gearing before making the change. Thus, if the calculated speed of the second gear is, say, eighteen miles per hour, the driver should wait until the work of surmounting the gradient has caused the engine to slow the pace down to that, and not try to make the change when the car is still doing twenty. Some little practice and intelligent observation is necessary before this can be nicely done, but that sort of thing is where much of the charm of driving a good car comes in.

Great care should be taken to see that both gear and bearings are kept properly lubricated, or worn surfaces will result, with much extra friction to be overcome, and if not quickly attended to other things may happen of a serious character. The driver should never allow any unusual sound emanating from the neighbourhood of the transmission gear to pass without investigation, for noise means wear—or something worse; thus Mr. Claude Johnson was on one occasion driving when he noticed a knocking or clanking sound apparently proceeding from his gear-box, which upon investigation proved to be a broken pin in the differential. He at once stopped for repairs. Had he gone on, the whole gear might have got adrift and been destroyed, necessitating a costly repair and many days' loss of time, as well as a *real* 'break-down' on the road, which, to say the least of it, is unpleasant.

In fig. 20 we have an example of a shaft transmission car, the type shown being the Renault, which I take not only because it was the pioneer of shaft transmission, but because the speed gearing is entirely different from anything else, and thus enables me to show a unique variation of wheel gearing. In the majority of cars which use the shaft form of transmission the variable gearing is very similar in principle to that last described. In our illustration A represents the motor, B the fly-wheel with contained clutch C, and D the gear-box. At opposite ends of the centre of this are two bearings, E, E, in which two shafts, F, F, are carried, these shafts being connected in the centre by the serrated clutch G. The rearmost shaft carries a break drum H, within which it is attached to the

universal joint I of the shaft J, the other end of the shaft carrying the second Cardan joint K and a bevel pinion enclosed in the case L, and engaging with a bevel wheel surrounding the differential, which is enclosed in the case M upon the back axle.

In ordinary driving the power is conveyed from the motor

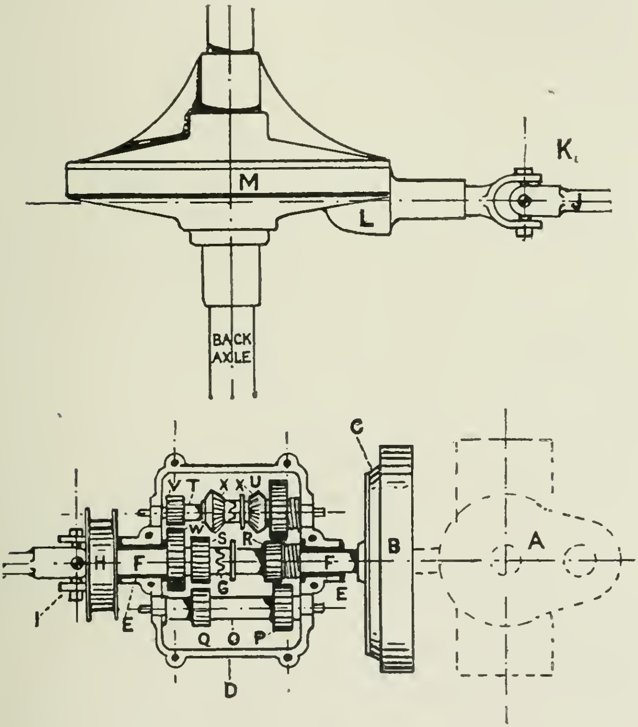


Fig. 20.—Renault Transmission Gear

direct through the shaft to the bevel gearing, which is a good point, although the power has still to be transmitted per bevel gearing round a corner; so that, although so called, it is not a true 'direct' drive. To obtain the second of the three speeds provided, a lever worked by the hand is so actuated that the two

shafts are separated by forcing the serrated clutch G apart, and at the same time causing the secondary shaft O, which is pivoted eccentrically in its bearings, to be rotated, so as to bring the two gear wheels P and Q, which it carries, into contact and gear with the two gear wheels R and S, which are carried upon the two halves of the divided shaft F F. The wheel R, which is fast on the shaft driven by the motor, now drives wheel P, which is in one with wheel Q, and rotates with it, and wheel Q, in its turn, drives wheel S and through it the transmission shaft and road wheels. Now it will be seen that R is slightly smaller in diameter than P, and Q than S, so that the speed of the road wheels is reduced in relation to the motor in the proportion of these differences. The third speed is obtained in a similar manner, but by swinging the other secondary shaft T in its bearings and bringing wheels U and V in gear with wheels R and W on the main shaft. As the differences in diameter between these four wheels is greater than with the other four, it will be seen that the speed reduction is proportionately greater. Upon the centre of shaft T will be seen a serrated clutch and two bevel pinions, X, X. This is the reversing gear, which is put into operation by separating the serrated ends of the shaft and dropping a third bevel wheel—not shown in the illustration—into gear with the other two, which reverses the movement between the two halves of the shaft, and consequently drives the main shaft in the opposite direction to that in which the engine is running. With this gear an even greater amount of care is necessary in changing gear than with the last mentioned, as the teeth of the different gear wheels are not slidden sideways into each other, but the two rapidly moving toothed surfaces brought up against one another. Several variations of this gear are now in use in cars which are said to have 'direct drive on the top gear.' In these the driven shaft or gear is set in line with the propeller shaft, to which it may be connected directly with a positive clutch. In this position the top gear is obtained. For the lower gears the two shafts are disengaged and the drive taken from one shaft to a countershaft parallel with it by means of toothed gearing and from the countershaft to the propeller shaft by

another pair of wheels, two or more pairs of gear wheels being provided.

In all these gear-driven devices the greatest care must be taken to see that full lubrication is provided. The gear-case should be kept sufficiently full of lubricant to enable the lower edges of the gear wheels to be constantly passing through it, and the lubricant used, whilst thick, should not be so thick that the wheels cut a channel for themselves in it and then practically run without any. In other words, a thick oil and not a grease is required. It is important, too, that the bearings of the shafts should not be allowed to get too much worn before renewal. All bearings will wear and will require rebushing, i.e. relining with new metal surfaces, and this should be done when any very perceptible shake or side play is detected in them. This condition of things will generally make itself known by increased noise from the gear, and the extent of the wear can be ascertained by taking hold of the shafts and trying what amount of movement both sideways and 'up-and-down' can be felt. The rebushing of the bearings is a matter for an engineer's shop, and not for the amateur's attention. What the latter has to remember is that 'a stitch in time saves nine,' and that neglect of perceptible wear savours of the 'penny wise and pound foolish' policy.

In the above I have but lightly touched on a question the importance of which is second to none in connection with car construction, and I trust I have not only made clear some of the principles employed, but the strong necessity of giving constant care and attention to this very important part if best results are to be attained.

II. FRAMES, SUSPENSION AXLES, WHEELS, STEERING GEAR, AND BRAKES

BY W. WORBY BEAUMONT, M.INST.C.E.

The parts of a car enumerated above are those which are least likely to be detrimentally affected by the want of knowledge on the part of the beginner. Most of them require little or no adjustment, and for the proper fulfilment of their functions the owner can but rely upon the skill of the designer and the honesty of the maker. Their proportions and relations are settled before the owner has anything to do with the car. Upon them, however, depends entirely the safety of the occupants of the car. The motor or engine, the gearing, the carburetter, the electric ignition connections, all may break or cease to play their parts, and the only result will be that the car ceases to be a locomotive. The worst possible accidents are, on the other hand, probable and almost certain if either axles, wheels, or steering gear break, or if pins or nuts be lost from either of them or from the brake gear.

Frames.—Frames are made of so many designs that no general instructions can be given regarding them, and whether they are sufficient in strength and trustworthiness depends very much upon the method of connecting the running gear and spring suspenders or hangers to them.

Most of the frames are still made as they long have been of rolled channel steel, and when of judiciously selected section they are perfectly satisfactory. On the other hand, some of the best makers still use an ash frame strengthened by longitudinal steel flitches, but many of the frames in the larger cars are now made of pressed steel plates of about $\frac{3}{16}$ inch in thickness. They are of channel section, varying in depth from the ends towards the middle where the depth is greatest as in the construction of a girder. The Mercédès frames were the first made in this way, but nearly all the leading firms now adopt

the method. The accompanying illustration, fig. 1, represents one of these frames. In this the transverse members are held by riveting and gusset plates, but in some of the most recent, as in those of Darracq, they are welded in.

Some cars have a main frame to which the spring hangers and other parts are attached, and a secondary frame to which the motor and gear-box, &c., are attached. This secondary frame may be so connected that the main frame is relieved of the local stresses which result from direct connection of the motor and gear.

The motor and the main clutch shaft must be truly in line, but if these two main parts of the mechanism are separately

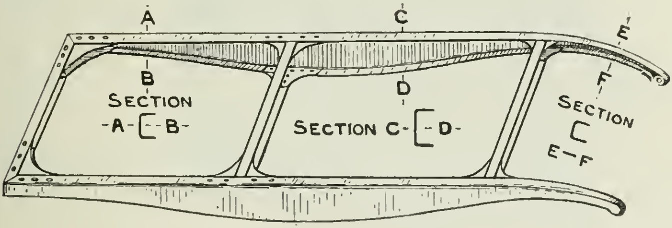


Fig. 1.—A Pressed Steel Frame

attached to a weak frame, this latter twists and bends sufficiently to cause trouble with the clutch, because the one part of the clutch is not parallel with the other, and the inner cone only presses locally in the outer cone instead of fitting all round. Clutches used much, when this is the case, slip most when slipping is least wanted, soon cause a great deal of trouble, and only complete refitting and renewal of the bearings can secure perfect action.

Many frames are made cycle fashion—of round tubes brazed together and with many of the ears and brackets for attachment of other parts brazed on. When the tubes are good and of ample dimensions these frames are satisfactory, but harm may so easily be done to the steel tubes by injudicious brazing that it is well to watch the frames carefully at all joints and connections,

so that any flaw or any loosened lug may be discovered. When spring hangers or brackets are attached to these frames so that they splay outward or out of the direct line of pressure from bracket to frame, they put a torsional stress on the frame which aggravates the tendency to fracture or loosening. Some of these frames are much narrower than the width between the springs, and the spring hangers are bent or splayed out to reach the springs after the manner of construction adapted in some pony traps. For these the system suffices, but for the heavier load and much higher speed of the automobile it is not

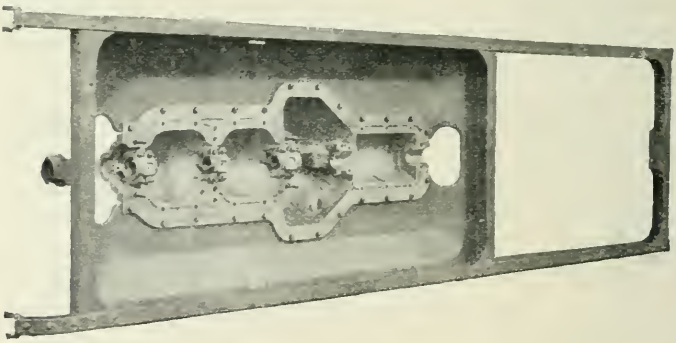


Fig. 2.—The Darracq Pressed Steel Frame

desirable. A frame which has some diagonal stays or parts which act as diagonals is very desirable, though few car frames are so made. Diagonal staying prevents some of the injurious racking stresses, and with the longer distance between front and hind wheels now common there can be little difficulty about their use. The most satisfactory frames in this respect are those of the Decauville car, in which a dished steel plate connects the main parts of the frame and forms a rigid though elastic support for the motor and gearing. A view of this frame with the upper part of the engine and gear-box removed is shown in fig. 2. The recent Darracq pressed frame is an adaptation of the pressed frame of fig. 1 type and in part of fig. 2.

Wheel-base.—In the earlier designs of cars the wheel-base—that is the distance between the axles—was made short in accordance with ordinary carriage-makers' practice. This reduced the length of road covered, but its disadvantages are serious. A long wheel-base is desirable not only for steady running on straight roads, but for the greater security it gives in running on greasy and bad-surface roads, and on curves and downhill. It also gives greater certainty and definiteness to the stearing. A very short wheel-base car is difficult to keep in a steady line, and it will easily turn quite round when side-slipping occurs. Long wheel-base lengthens the frame and makes extra care necessary in securing sufficient strength, partly because of the greater length unsupported between the front and back springs.

Springs.—The length and the number of plates in springs of the motor-cars of similar weight and power by different makers vary very much, and without much reason. More attention would no doubt be paid to this point were it not that the general use of pneumatic tyres hides imperfection in this respect as well as others. Springs of insufficient strength, and particularly of the front or steering wheels, are a source of great danger, and frequent careful examination should be given them; but springs are not necessarily of insufficient strength because they appear to be light. Short springs are generally undesirable, as being more liable to break with an ordinary range of flexure than the longer spring, the bending per unit of length being greater. Stiffness in short springs is avoided by lightness, which is likely to lead to breakage, especially when the hole for the pin through the centre is not made as small as possible, and when the spring rests upon too long a seat under the strap bolts. All the conditions as to best thickness and number and width of spring leaves are best met by springs of the longer type. They should always be bedded upon the axle, with a piece of leather or wood between them and the axle and between them and the clip bolts holding them on. Whenever possible a hard rubber buffer should be attached to the centre of the spring as a

chock-block to avoid the severe shock to springs when the frame goes down the full range of the springs, as when running over a gutter.

The breakage of a spring leaf most frequently takes place at the centre of the leaf, where the contrary flexure occurs between the two clip bolts. A broken leaf may thus be made to do duty temporarily by clipping it up to the other leaves by means of clips which can be bought for the purpose, and one of which at least should always be carried with the spare parts on a car.

Generally a car suspension consists of four springs all placed longitudinally, one to each wheel, but some cars are fitted with cross springs at the back. These are becoming more general, and their use secures more perfect cushioning and relief from severe shock than the side springs alone unless these are of considerable length and have very little curvature.

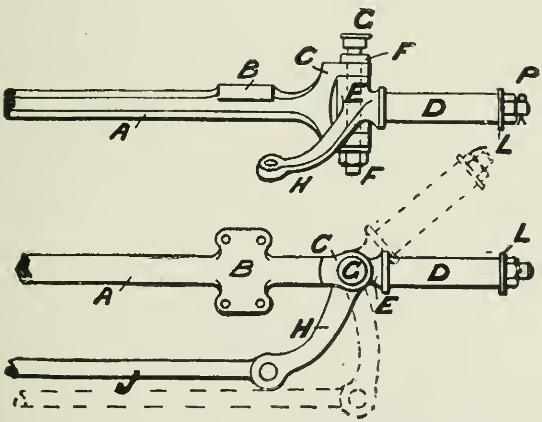
Springs are connected to their hangers at one or both ends by means of a pair of links, which radiate to allow for the bending and straightening of the springs. These links are often much too short for free movement, sometimes not more than $1\frac{1}{2}$ inch between the centres of the pivoting bolts. These should never be shorter than 2 inches; 3 inches is better, even in voiturettes, and more than 3 inches in the larger cars.

Very considerable direct and indirect stresses are visited upon the bolts and nuts by which spring hangers are fastened to the frame, and these should be examined from time to time although they are fixtures.

It should always be remembered that the breakage of a front spring may not only of itself be the cause of a severe accident, but that even when the breakage is only partial it will cause the steering gear connections to become inactive or be moved with difficulty; and this is very likely to lead to disaster.

Axles.—In all modern motor-cars, with one exception, the

front or steering axle is, as to the greater part of it, a fixture to the spring and frame, just as is the hind axle of a brougham. The ends only of these axles move for steering, namely the part which is in the wheel and a short piece which is jointed to the fixed part of the axle. The most common form is as sketched in figs. 3 and 4, which are a side elevation and plan of one end of a steering axle. In these A is the fixed part of the axle, B the pad upon which the spring is fixed, C the forked end of the fixed axle, and D the movable part pivoted at E in the fork of the pin F, the head of which carries a



Figs. 3 and 4.—Typical Ackerman Steering Axle

lubricator at G for supplying oil or grease to the pin. On the part E of the pivoted axle is an arm H, by which through a connecting-rod J, actuated by connections with the steering handle or wheel, the axle D is moved to any angle for steering, as indicated by dotted lines. All the pins and nuts on these connecting-rods and arms need the most careful attention, and frequent scrutiny to prevent wear or the loss of nuts and pins. The buyer should avoid a car with insufficient strength or quality of work in these parts. This form of axle, known in this country as the Ackerman

axle,[1] though invented by M. Lankensperger in 1818, is of very great value in motor construction, as the ordinary carriage front axle, with locking plate and centre pins, would not only be extremely inconvenient, but it would not give so stable a car under the higher speeds, the wheel base with Ackerman axles remaining nearly the same when turning a corner as when running straight.

These advantages are obtained with the disadvantage of the jointed short arm at each end of the axle with its attendant joint pin, nuts, and lubricator. These do not, however, necessarily give any trouble to a careful user. There are numerous forms of this axle, differing in form of pivot and as to the method of holding the road wheel on the axle D, which in the form shown is kept in place by a washer and nut N and a split pin P. All these details are like those of well-known forms of carriage axles, but some, such as the Wolseley car axles, run in ball bearings, and these any cyclist will soon understand. The strength of the fork A is much increased by the firm holding together of the two jaws by the pin F, and hence it is necessary to see that the nut at the bottom is so used that it does hold the jaws together, and it must not be allowed to become loose. The Mercédès cars have been fitted with several forms of steering axle, but that now used is a well-designed modification of the type shown by figs. 3 and 4, with the fixed part of the axle including the vertical parts of the fork jaws made of I section. In another variety the fork is formed on the short axle.

The hind axles of nearly all the chain-driven cars is a fixed axle similar to but stronger than ordinary carriage axles, and they require the same but more frequent attention. The driving wheels on these axles have sprocket wheels fastened to them, and are driven by chains which run upon them and on the smaller sprocket wheels or pinions on the ends of a spindle which is driven by the motor. This spindle is in two parts, connected by gearing, which is known as differential or com-

[1] See 'Motor Vehicles and Motors,' p. 567.

pensating gear, its object being to drive the road-wheels so that though both are turned by the same rotating source, they may turn at different speeds when turning a corner; the two wheels then describe parts of two circles of different sizes, the one wheel advancing perhaps five or six feet to one foot of the other. The differential gear will be explained with reference to the live hind axle. If both wheels were driven at the same speed on a spindle without differential motion, then one or both wheels would have to skid and rub over the ground for the whole of the difference of five or six feet to one. Railway and tramway wheels do this, but the curves they traverse are, except on tramways, always much larger, and the difference between the curvature followed by the two wheels is small. On tramways, however, it is the cause of very great strains and wear, and is a very unmechanical and barbaric form of simplicity.

So far as driving is concerned the automobilist has only to remember with regard to the fixed hind axle that the axle should be kept well oiled, and that careful examination should frequently be given to all nuts and pins.

The Differential Gear.—The live hind axle used in so many of the more recent forms of light car is a very different thing, and needs more attention, as part of its structure is the differential gear.

The differential gear acts on the principle of the action of the pair-horse whippletree and equalising bar, the gear acting continuously in a rotating circle while the whippletrees act only through a small range rectilinearly.

The gear may be explained by reference to the diagram fig. 5, which illustrates a Mercédès differential gear as used on the sprocket shaft, driven by a horizontal jointed rod from the motor and a bevel pinion.

The differential gear consists of two bevel wheels F and G, on the two halves A B respectively of the sprocket shaft, and two or more bevel pinions H. These bevel pinions are loose upon the pins I I on the end of the piece K, carried round by the bevel wheel J, and case J′. If the resistance to the road

wheels and therefore to the two parts A and B of the sprocket shaft be the same, the pinions H will by their teeth impart equal degree of rotation to both F and G, but if the wheel driven by B be on the inner side of a curve or meets with obstruction greater than that to A, then the pinion H will turn on its pin K, and allow one wheel to move faster than the other. That is to say, the pinion H will impart the same push to either shaft A or B, but if one of these moves more easily than the other from any cause, it accommodates that one by

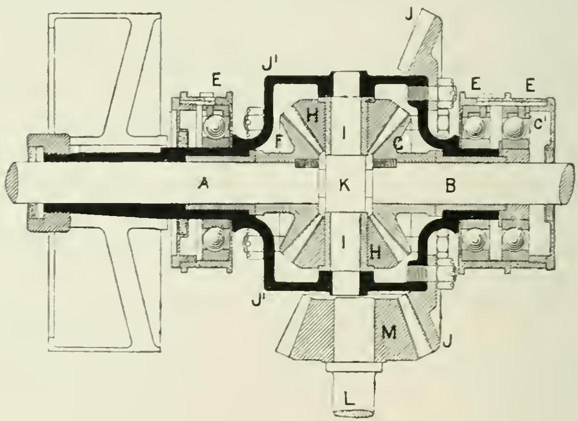


Fig. 5.—A Differential Gear

itself turning and allowing that shaft to move more rapidly than the other. This accommodating action of the gear is important for free turning of corners, but it has its disadvantage, in that if one wheel, while the vehicle is on the straight, meets with more obstruction than the other, the gear allows it to be obstructed, and tends to push the other wheel round against the action of the steering gear. Correspondingly, if one wheel is on a greater thickness of greasy mud or a more slimy bit than the other wheel, it has more freedom of, and help to, rotation than the other, and skidding or side-slipping on the greasy road results or is aggravated. Hence in the heavy

steam lorries, means are provided for throwing the differential gear out of action.

On many cars the bevel wheels of differential gear have been too small in diameter, and hence they gave insufficient room to admit pins of sufficient size to carry the pinions H, and rapid wear and breakage has resulted. In any case it is necessary to have ample diameter for these parts, and to see that they are kept well oiled, not only at the pins and gear teeth but at the centre of the axle, where the two parts are joined by means which allow them to rotate differentially on a centre pin and in the bearings in the differential gear-box which surrounds the wheel J. At M is shown the bevel pinion on the end of the spindle L, which is driven through a jointed rod by the motor. The means of transmission of the power to this spindle have been described in other chapters. The automobilist should occasionally jack up the rear of the car so that both drivers are free of the ground, so as to see that the wheels run equally free when either wheel is held, thus testing the free working of the differential gear, finding slack if it exists, and testing generally the condition of the gear and connections.

Steering Gear.—The loss of a ship's rudder is a small loss comparatively with that of the breakage or carrying away of an essential part of the steering gear of a motor carriage, especially of a high-speed car. The ship will continue to float and in most cases the stopping of the engines removes immediate danger from collision. With a broken steering arm or connecting-rod, a car with its occupants may be hurled into a ditch, or ravine, or river before the driver has realised what has happened, and long before the brakes could do any good. The first provision against the helplessness that must, and the disaster that probably would, follow broken or disconnected steering gear, is sufficient strength in the parts. It should be as direct and simple in arrangement as possible, because least liable to disarrangement and because gear with chains and short rods and connections through springs have so many

more points for possible looseness and losses and more to examine and yet be uncertain about. A few pounds in weight will make all the difference between weak and bending untrustworthy parts, and certainty, so far as strength will give it. The second means of providing against accident is frequent minute inspection of every connection, tightening of nuts, renewal of worn pins, assurance that pins cannot leave their place or split pins be lost, and careful oiling and covering of joints so as to prevent ingress of grit and reduce wear as much as possible.

The choice between locked steering gear and what is commonly called direct steering gear is very much a matter of personal choice. The locked gear generally acts through a worm and wheel or quadrant, and remains where it is set by the driver. The free or direct gear moves with the impulse or pressure brought against the steering wheels or one of them by any ruts or obstructions on the road. This movement has to be resisted by the hand of the driver, as it is in some of the steam-cars with lever-steering handle and many of the wheel-steering light cars. An objection to the locked steering gear is that the worm gear rigidly holds the whole of the connections between it and the steering axle. Hence any shock by blow or heavy push at one wheel has to be withstood in all its force by the steering connections. The lever or free gear on the other hand is not rigid. It is accommodating, and the shock on the steering parts is very much lessened, and in many cases eliminated, by very small movement of the steering lever or wheel. The objection to this is that the hand has to accommodate itself to and permit this movement and still preserve the steerage control. If it be resisted the hand and arm feel in a very disagreeable way the effects of the shocks, especially at high speeds on bad roads, and of which the steering gear is relieved. The driver, however, soon learns to keep a loose but ready hand on the steering wheel or lever just as in riding a bicycle or tricycle. On very light and moderate speed cars lever or free-wheel steering gear would seem to be in every way sufficient and quicker in action than the locked gear, and

while running on good smooth roads there is very little tendency for the steering wheels to wander one way or the other.

For the heavier and higher speed cars the locked steering will probably continue to be preferred, the steering connections being relieved to some extent of the severity of shocks by the interposition of spring buffers in the rod ends, thus securing the advantage of fixity of position of wheels and direction of running under any circumstances. It may be remembered, however, that with the long wheel-base of the passenger brakes run by the Lifu Company three or four years ago, the lever-steering worked with great ease at thirty-five miles per hour, but the axles of the wheels were inclined so that the point of incidence of the wheels on the road was directly under the steering-axle pin, and hence most of the shocks were delivered to the axle and not to the steering gear.

The automobilist should frequently jack up the front of his car so that the front wheels are free of the ground. Then he can test the condition of all the steering-gear parts between axle-arm and steering pillar, and see and feel every joint and find out where, if any, and how much looseness or wear there is in any part. He cannot do this properly while the weight is on the wheels. Looseness between steering wheel and end of steering pillar can be found at any time. He should never allow 'hurdle fitters' or 'horseshoe fitters' to attempt to refit or alter any part of his steering or other gear, any more than he would allow a 'hedge carpenter' to alter or repair the body of his car or the Chippendale chairs in his drawing-room. Only good experienced workmen, and above all trustworthy workmen, should be allowed to do this work. The refitting of steering the worm and quadrant or nut on the steering screw, when that form is used, must be done by a good fitter, even if the double nut, with one half adjustable independently of the other, be used.

Brakes.—Next to trustworthiness in axles, wheels, and steering gear, the sufficiency and certainty of action of the

brakes are of the utmost importance. So long as the axles do not break, and the steering gear steers, an expert driver can rub along with very poor brakes until familiarity with risks and dangers leads him into a smash, or until some very near squeak makes him shudder when he thinks about it after he is in bed and the light out, and then he looks to it on the morrow. Of these incidents we do not hear much, but we all know of the smashes and the fatal accidents that have happened to those on runaway or brake-given-way cars. For the beginner there is no working part of a car so necessary to his safety as the brakes. He finds that stopping is very frequently more important than going if he values either his life or that of others, or wants to save his car and is not anxious to pay for smashing carriages or horses. Even the lighter French vehicles are no longer fitted with brakes not big enough for a bicycle or good enough for a horse-rake.

Many brakes have in the past been generally made or fitted so that they will only hold a little in any direction, some that would only hold well in one direction, and some that held too well, came into action too severely in one direction, namely forward, and very few that held well in the backward direction. A great deal of attention has lately been paid to this question, with the result that brakes long well known to mechanical engineers have been applied to motor vehicles.

A common form of brake that will hold only in one direction is shown in diagram fig. 6. In this a brake drum A is surrounded by a brake band B, fastened at one end to a fixed stud at C, and pulled at the other end D by a rod F, connected to a pedal E. This brake acts perfectly so long as the drum A rotates in the direction shown by the arrow, because the friction of the band on the drum from near C to D pulls on the band in the same direction as the pedal, and thus the greater the pull at D the greater the frictional grip round to D. As soon, however, as the car is reversed or moves backward, so that the drum turns in the opposite direction, the friction of the band upon the drum pulls the band round towards the fixed point C

and further frictional grip does not take place, as the tendency is to reduce the pull on C. If now the band be coupled at C to a lever pivoted at H, as in fig. 7, the other end being coupled to the end D of the same lever and pulled by the rod F and pedal E, the brake will act both ways. If the drum be turned in the backward direction of the arrow, the pull

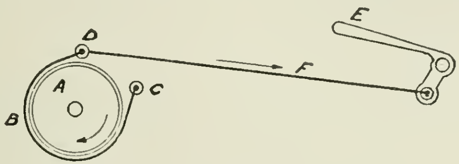


Fig. 6.—Brake which holds in one direction

at D will not be lost through the effect of the fixity of the point C, for both ends C and D are pulling on the drum, and increasing the pull on F increases the frictional hold in a rapid degree.

A good form of brake is that shown by fig. 9, in which the pull on the rod F from pedal E pulls the arm D, and thereby

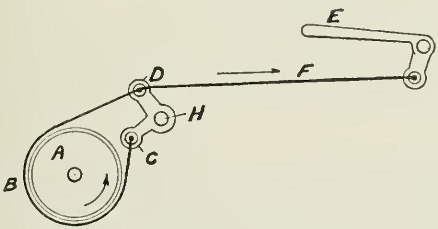


Fig. 7.—Brake which holds in both directions

pushes the links C outwards and forces the blocks B outwards into the brake drum ring A, the whole of the brake tackle shown being prevented from rotation by the radius rod G, attached to the frame. It will be seen that this brake holds equally well in either direction. It is made by Messrs. James and Brown.

Other forms of brakes which act in both directions have been adopted, as in the Cannstadt-Daimler cars; and more recently much better and indeed quite satisfactory brakes, acting externally on drums or internally by expanding into drums, by a large number of makers including the Daimler, the Thorneycroft, Wolseley Company, Darracq, De Dion, Bouton, Decauville, and the Clarkson Company. All but the substantially made and well connected brakes should be avoided.

Brake bands with wood blocks attached will work very well, but well-fitted bands with metal-wearing surfaces are much better, and brakes made up of small wire ropes and tacked or tied on or threaded wood blocks should be rejected.

However good the brake, it needs careful inspection and

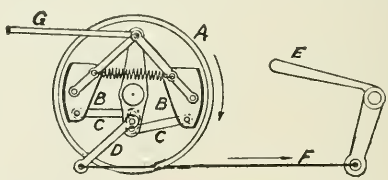


Fig. 8.—Brake which holds in both directions

occasional adjustment, and much more thought than is usually bestowed on so important a factor of safety.

A fruitful cause of accident and of wear and tear of brakes, tyres and car generally, is the abuse of a good firm-holding brake. Maintaining high speed to the last moment and depending on sudden application of the brakes is a very bad and often dangerous practice.

The injudicious use of brakes or the rash driving which entails the excessive employment and the abuse of brake power, is not only to be condemned because it is so likely to cause the breakage of the brake gear, and so render a driver

absolutely helpless, but because it is one of the fruitful causes of rapid tyre wear.

When a car weighing with its passengers one ton is stopped from a speed of 20 miles an hour in a length of say 15 yards, the accumulated energy in the mass in motion is about 13 foot-tons, and this is dissipated by work done on the tyres. It is remarkable that even the best of tyres stand this enormous strain as they do. At 20 miles per hour the car travels 45 feet in the time taken to stop it, but the Automobile Club trials of January 1902 show that the distance in an assumed emergency stop may be much shorter than this, and it will not be an exaggeration to assume that the car may be stopped in 35 feet or in from $2\frac{1}{2}$ to 3 seconds; and in this space the wheels will have made only from four to five revolutions, according to their diameter.

The whole, then, of the work, equal to that of raising a ton 13 feet high, is done by the tyre surfaces in four or five turns, or less than three seconds. This statement is sufficient to enable even those who have the very least acquaintance with mechanical matters to appreciate the danger and the costliness of the injudicious driving that leads to the abuse of the brakes.

It may be desirable to record here that the Automobile Club brake trials above referred to showed that on a flat and nearly dry good road a car could be stopped at the speeds and in the car lengths given below:—

From 11 to 14 miles per hour in $1\frac{4}{5}$ car length.
From 15 to 17 miles per hour in 2 car lengths.
From 18 to 20 miles per hour in $2\frac{3}{4}$ car lengths.
From 20 to 24 miles per hour in $3\frac{1}{2}$ car lengths.

Wheels.—For *voiturettes* there does not appear to be any structural superiority in wood wheels, making them in this respect preferable to well-made and well-proportioned wheels of the cycle type. They are a little more easily cleaned, and are, perhaps, neater in appearance; but even this is doubtful in very light cars. For the heavier cars the wood wheels of

the Hancock type are preferable because of their combined strength and resilience, as well as for advantages as to cleaning and appearance.

There are, however, no points in particular that the beginner has to consider except to beware of wheels made with very light spokes and felloes. It is too frequently assumed by makers of light cars and also of some of the heavier cars that wheels are of sufficient strength if they are capable of carrying their load under all ordinary circumstances of running, when the stresses are mainly in the radial direction of the spokes. The side stresses which occasionally arise are, however, much more severe and dangerous, and for this reason the spokes should be of ample strength and number in the steering wheels as well as in the back wheels. Look well to the joints in the felloes and every joint of every adjoining spoke in the bosses. Well-made wheels show no movement at these points after hundreds of miles of running. For the most part the buyer must rest upon the honesty and reputation of the maker, but he may help the longevity of the wheels by judicious and gradual use of clutch and brakes, and by guarding against loose or lost nuts on the wheel boss flanges or slackness on the axles. Any slackness of the rim on the felloes should be attended to by a wheelwright. The cycle wheels of the light voiturette seldom require attention except in case of accident, and they may generally be entrusted to any of the accredited repairing shops.

As a rule it may be taken that the larger the wheel the smoother the running of the car. Very small wheels are to be deprecated on this ground, and also because the severity of the shocks to the whole car increases very rapidly on bad roads with decrease in diameter of wheel, for reasons which have been given in the book already mentioned.[1]

All the wheels should be of the same size, because the same tyre will then fit any wheel, and half the number of spare covers and inner tubes are required as compared with the requirements when the wheels are of different sizes.

[1] 'Motor Vehicles and Motors,' p. 605.

The appearance of a car with wheels of equal size is moreover better than when the steering wheels are smaller, and except that custom, dictated by the old locking plate and centre pivoted axle, required the small wheels in front, there is not only no reason for small steering wheels in motor carriages, but if any difference is made they should be larger than is necessary for the driving wheels.

CHAPTER XI

TYRES

By C. L. Freeston

It is a curious paradox, but none the less true, that while the public has still to be converted to a more widespread appreciation of the efficiency of the mechanical motor, to the automobilist himself the problem of the day, and of many days yet to come, is how to find a perfect tyre. Excellent motors have been in use for years—in fact, it may be said that in actual practice the engine is the least likely portion of the car to fail; and though improvements have been effected, and others will yet be introduced in this and other parts of the machine, to the gratification of every driver, he would willingly resign them all and use, say, a Daimler motor of 1896, if only he could be ensured entire immunity from tyre troubles. No one is exempt from this apparently chronic obstacle to pleasurable driving; the novice with his first car experiences sundry mechanical difficulties which the experienced hand may avoid, or quickly conquer if they occur, but every automobilist alike is a prey to the inconvenience of punctures, and the expense of upkeep of a costly and too easily perishable tyre equipment.

Arguing from the analogy of the cycle, in respect of which the use of the pneumatic tyre has been so signal a success, the average reader may find it difficult to understand why the motor-car tyre should not be just as satisfactory, provided that its substance be increased in converse ratio to the weight it has to carry and the work it has to do. This, however, is unfortunately the crux of the whole matter. Various factors

enter into the situation which are virtually unknown in the case of the ordinary cycle. The motor-car not only surpasses in speed the greatest efforts of the cyclist, but also maintains a high momentum for protracted periods ; hence overheating is one factor, not to mention others, which is present in the motor-tyre, but which in cycling is only known to the Alpine rider who 'coasts' for twenty miles or more with the brakes on all the time. The motor-car, too, must be driven through everything, including long patches of 'new metal,' and must take its grip on bad surfaces as well as good ; the cyclist, on the other hand, can often pick his way, and, if not, can get down and push his mount, the tyres thus making a rolling contact only instead of sustaining the driving friction which does all the harm.

With all its drawbacks, however, the pneumatic tyre is almost indispensable for most types of motor-carriage. In speed, in comfort, in saving the mechanism from pronounced concussion, and in facility of steering, there is no question as to the superiority of the air chamber as compared with solid rubber. The curious fact, moreover, remains that in the very circumstances which emphasise the weak points of the pneumatic tyre the solid would be even worse. High speed and a heavy car form a combination which tests the pneumatic tyre severely, but the solid tyre in like circumstances can with difficulty be kept on the wheel at all. At high speed, again, the pneumatic tyre is particularly liable to puncture ; but the very fact of the tremendous speed necessitates the rejection of the solid, because the comfort of the passengers, the conservation of the mechanism from jar, and the ease and safety of the steering become more than ever important.

It is a melancholy fact that our French neighbours have all along been even more ahead of this country in regard to the manufacture of motor-tyres than of motor-cars themselves. This circumstance for years pressed very hardly on the English amateur. In 1901, however, the Dunlop Company permitted the tyre which was most favourably known abroad, i.e. the

Michelin, to be imported into the United Kingdom under licence, as the 'Clipper-Michelin,' and it at once became the standard type of pneumatic tyre among British users.

THE CHOICE OF A TYRE

Assuming that the reader is purchasing a car for the first time, he may reasonably specify the fitting of Clipper-Michelin tyres and leave experimenting, if so inclined, until a later date. This type of tyre is taken as a standard for purposes of description and illustration of the processes of repair.[1] Several items, however, require previous consideration. It is more than likely that though the right make of tyre be chosen the novice may go wrong as to certain points of detail. In the first place it is of the highest importance that the diameters should be correctly apportioned to the weight, and secondly, whatever the size of cover, that it should be of the correct degree of substance. Thirdly, it is advantageous that all the wheels should be of equal size.

As regards diameters, it may be stated that the Michelin tyre is made in various sizes, ranging from fifty-five to one hundred and twenty millimetres, or two and a half inches to four and three-quarter inches. The tendency of makers is to fit too small a diameter, and in most cases it is safe to ask for one size larger than that which is offered. In the 'Guide Michelin,' however, a complete table is provided in which the suitable diameters for given weights are specified, together with the degree of inflation to be allowed, and these data should be studied with due care. The 'Guide,' a most useful volume of 575 pages, is included with the Michelin repair outfits, or may be obtained gratuitously from the firm. With regard to substance, the covers are of three types, the *léger*, the *renforcé*, and the *extra-fort*. The first-named may be discarded altogether, the second fitted to the front wheels if the

[1] Figures 1 to 16 have been selected by permission from the excellent *Guide Michelin* and redrawn, in some cases with slight emendations.

car be very light, while the third should invariably be chosen for the driving wheels, and preferably for the front as well. It is well to bear in mind that the average English road is not as good as the average French road, and to make allowances accordingly.

REPAIRS

The repair of a Michelin motor-tyre approximates to that of an ordinary cycle-tyre with beaded edges, save that much greater resistance has to be overcome in the former type owing to its substance, while the winged nuts add one new feature of complication. On the other hand the motorist has full access to the wheel, and has no fork-blades to impede his operations. While it is probable that most automobilists will have previously become acquainted with a cycle-tyre, it is desirable to describe the repair processes throughout.

It is essential that a satisfactory repair outfit should be obtained at the outset, and nothing on the market can be compared with the Michelin *nécessaire de voiture*, which is worth buying if only for the special levers it contains, apart from the excellence of the tackle generally. One of the levers (see fig. 1) has three projections intended for use with covers of 65, 90, and 120 millimetres

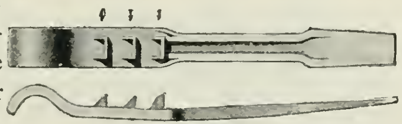


Fig. 1

respectively; the other lever has a hook which comes in handily when replacing a large cover (see fig. 13). The larger the tyre the more essential are the levers; a new cover is also much stiffer than one that has been used for a considerable time. In the case of a small or medium-sized tyre, not too new, a very strong pair of hands may render the levers superfluous.

When the driver has reason to suppose, from the bumping of the car on one side, or lack of certainty in the steering, that a tyre is punctured he should stop at once to examine. It is of the highest importance that a tyre should not be ridden

deflated, but it is not always easy to detect the fact of a puncture at once in a back tyre, when the road is itself bumpy. In a four-seated car the rear passengers should glance occasionally at the driving-wheel tyres out of consideration for the driver, and if either of them be splayed at the point of contact with the road he should be apprised of the fact at once.

If he decide, upon dismounting, that the tyre is punctured, and not merely short of inflation, the car should be jacked up so as to permit free movement of the wheel. The tyre should then be cleaned, the best article for the purpose being a brush with wire bristles; the type is known as a 'jeweller's scratch-brush.' Loose dirt should also be wiped from the spokes. If these precautions be neglected every movement of the wheel will cause particles of dirt to fall into the hollow of the cover, whence they must be removed at all costs. If a cloth be damped with water or petrol the dirt will cling to it readily, and can be quickly wiped away.

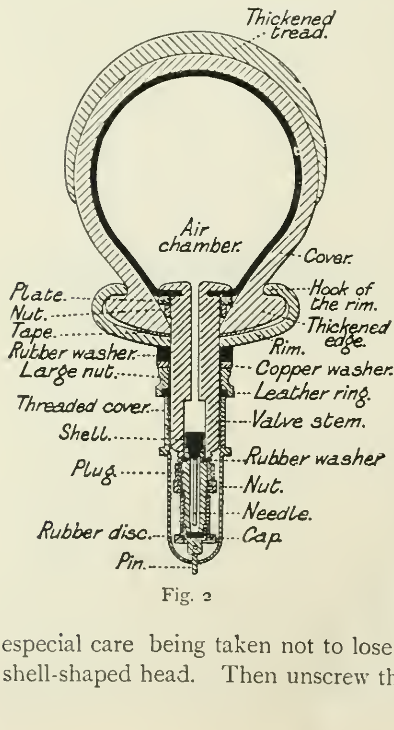


Fig. 2

To Remove the Tube.—To remove the air-chamber for examination the valve cap should be unscrewed and inverted, the pin being then pressed into the valve stem so as to push away the needle (see fig. 2). Deflation may be expedited by loosening the large nut and pulling out the plug, especial care being taken not to lose the little needle with its shell-shaped head. Then unscrew the winged nuts almost as

far as they will turn without detaching them from the bolts, and push the latter upwards until the nuts meet the rim.

The beaded edge of the tyre should then be forced inwards all round the rim by the left hand, the right hand assisting the operation by inserting the point of one of the levers. Then moisten the blade of each lever to make it glide more easily on the rubber. Take hold of the cover, as in fig. 3, with the left hand, at a point between two winged nuts, and not near the valve. Push forwards with the palm of the hand and the thumb, and simultaneously, having inserted a lever, work it downwards with a laterally oscillating movement until it assumes the position shown in fig. 3. Depress the haft until the blade is horizontal, and then slowly work the point again

Fig. 3

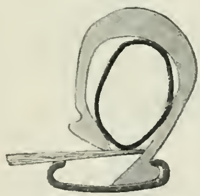


Fig. 4

with a sideway oscillation, until the opposite edge is reached, as in fig. 4. Still holding this lever firmly, insert the other at a point from ten to fourteen inches away, according to the size of the wheel; roundly speaking, the distance between the levers should be a third of the diameter of the rim. Avoid, however, placing either lever near the valve or one of the winged nuts.

Having worked the second lever forwards in like manner to the first (see fig. 5) depress the hands towards the hub (see fig. 6). This should bring the beaded edge right over the rim; if the movement fails the levers are too far apart, or if the edge comes over but slips back again they are too close. The remainder of the cover may be detached with the hands alone in the case of a voiturette tyre, but otherwise the right-hand lever must be re-inserted six inches further down, and again

depressed, the process being repeated until detachment is complete. Care should be taken that the winged nuts remain flush with the rim throughout.

If a single lever only be available the removal of a cover requires more strength and more dexterity. The left hand should

Fig. 5

Fig. 6

press the cover outwardly as much as possible, the point of the lever should be insinuated between the beaded edge and the rim, but not beneath the air-chamber, and the position shown in fig. 7 should be attained, by pulling the cover forward with

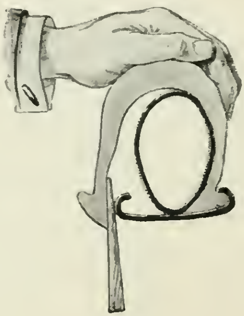


Fig. 7

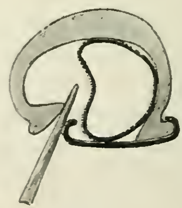


Fig. 8

the left hand and depressing the lever with the right. Avoid the position shown in fig. 8. Slide the lever, which should be moistened, between the rim and the beaded edge, and as the latter is progressively unhooked press downwards on the cover, as in fig. 9, to prevent any slipping back. The ease or other-

wise of the removal with one lever depends upon the size and age of the tyre; two levers are in most cases to be preferred.

To save time on the road it is usual to remove the air-chamber bodily and replace it with a new one, deferring the repair of the puncture to a more convenient occasion. In this case the valve should be loosened by unscrewing the large nut and rubber washer, and pushing the stem upwards until it leaves the rim. The air-tube should then be detached all round with the fingers, great care being exercised lest the rubber be adhering to the lining of the cover, owing to an insufficiency of chalk having been employed when the tube was last fixed, and also lest, as is very probable, the nail, flint, or other puncturing instrument, be still lodged within the cover, in which case ungentle handling may tear the tube. If the cause of the puncture be found, or even if there be a visible cut right through the cover, the corresponding spot on the tube should be determined, when a hole will probably disclose itself if the rubber be slightly stretched. The puncture should at once be marked with a coloured pencil, whether the tube is to be repaired forthwith or not. Then do not fail to remove the nail, or other cause of damage, from the cover.

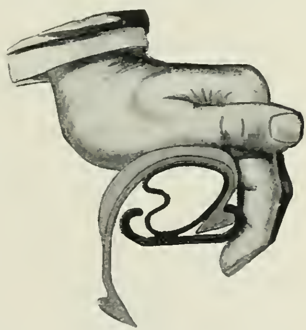


Fig. 9

If no spare tube be available, and the one *in situ* must be mended there and then, it is not necessary to loosen the valve in the first instance, as the puncture will probably be easy to locate, and may be at such a distance from the valve as to render a repair feasible without removing the entire tube. If the valve has to be detached, however, and the cover is of 90 mm. diameter or more, the lever with three projections should be employed, as in fig. 10, to hold up the cover.

To Repair a Puncture.—This process is simple. Select a

patch from the repair-box, of small size if the puncture be a mere perforation, but larger if the tube be cut. Clean the tube round the hole with glass-paper or petrol, brush dry, and then apply solution, over a space somewhat larger than the patch. Next cover the patch with solution also, on the side that is not bevelled. In each case the solution should be thinly and evenly spread, not in clots. Wait until all traces of moisture have disappeared—a point of paramount importance—and then fix the patch upon the tube, pressing the surfaces firmly together. There should be no ambiguity about the adhesion; the patch will stick like a leech at once if the solution has been thinly applied and sufficient time—from five to ten minutes—allowed for it to dry.

To Repair the Cover.—Before replacing either a new or repaired tube the cover should be attended to. If the hole or cut be very small, it will suffice to plug it with cotton wadding, soaked in solution, to prevent the ingress of water or dirt; the possibility of the air-chamber, however, under strong inflation, forcing its way into the aperture and bursting must be borne in mind, and when doubt exists as to the safe course to follow an oblong patch of canvas should be applied instead. The lining of the cover should be cleaned with glass-paper and solution spread on the fabric and on the canvas patch, as described above in the case of the air-tube. Apply a liberal dose of powdered chalk to the patch when fixed.

Replacing the Tube.—Considerable care is requisite when inserting an air-chamber. It should first be plentifully chalked, and a handful of chalk should also be placed in the well of the cover, and distributed by revolving the wheel two or three times. The opposing surfaces are thus well lubricated, and the possibility reduced to a minimum of nipping the tube, a factor which M. Michelin has declared to be the cause of fifty-one per cent of the injuries to air-chambers. Ensure that the tube is entirely deflated before replacing; to effect this it must be rolled upon itself and all the air squeezed forwards towards the valve, all the parts of which

must previously have been detached excepting the plate and nut at the base of the stem. Before replacing the tube, see that the overlap at the join is facing towards the back of the car, and not forwards. Then push the stem through the rim, meanwhile holding up the cover as in fig. 10. Place the rubber washer and large nut on the stem, but do not screw right home. The tube should then be passed round the bed of the rim, without any twist, and without being slack at one point and stretched at another.

Fig. 10

Now insert the remaining parts of the valve, except the cap, and inflate slightly, just sufficiently to make the air-chamber round, but without the least stretching of the rubber. Then pass the hand all round, between the tube and cover, to make sure that no creases remain.

To Replace the Cover.—Unscrew the rim nuts sufficiently to allow the valve to be pushed upwards, and the beaded edge to pass into its place. Force as much of the cover into

Fig. 11

Fig. 12

position as is possible by pressure from the hands, and then insert the lever as in fig. 11, and by lateral oscillation work the remainder into the hook of the rim. If the cover assumes the position seen in fig. 12 replacement will be difficult. In that case fix the lever with a single prong in the position shown in fig 13, and depress the other lever. Then bring the levers towards each other, and push the cover along the

inclined plane formed by the lower lever, as in fig. 14. Withdraw the upper lever, and, by raising the other lever, force the cover into the rim, afterwards tucking the edge beneath the hook by reiterated pressure from the point.

As each bolt is reached it should be pushed upwards as far as it will go when the winged nut is unscrewed to the last limit, and when the cover is in position all the way round these bolts should be worked up and down to determine whether the tube be nipped. The movement will, in that event, release the tube, and the bolt should come back much as the key of a pianoforte after pressure from the finger. If the bolt cannot be pushed upwards the beaded edge is not accurately bedded.

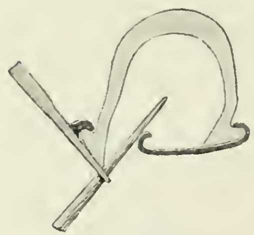


Fig. 13

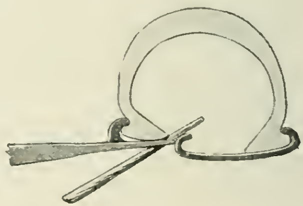


Fig. 14

It now remains to ensure that the air-chamber is nowhere nipped. Seize the cover with both hands, and with the thumbs force the beaded edge towards the centre of the rim. Make the circuit of the tyre in this way, and if the red tube be nowhere visible it is not nipped, but if it project at any point it must be pushed inwards with the lever.

The tyre may now be inflated, care being taken, in order to avoid wasted effort, that there is no leakage between the nozzle of the pump and the milled cap into which it is screwed, or between the latter and the rubber pipe, or between the nozzle and the valve. After inflation see that the valve nut and the winged nuts are tight to the rim, or wet will penetrate to the tyre.

To Change a Cover.—Remove the inner tube, then detach the winged nuts and take out the bolts. Pass a lever not only under the detached edge of the cover but also beneath the one opposite, as in fig. 14. Depress the lever, and pull the cover forwards. As soon as about eight inches of cover have been levered off, the rest can be removed with the hands.

Replacing a Cover.—In this operation the beaded edge on the far side must first be fixed, care being taken to have the notch exactly opposite the valve hole, and that the cover does not pucker in one part and stretch in another. Insert the bolts in turn, holding up the cover as in fig. 10, or by means of the new Michelin double prong. Then replace the air-chamber as before.

Bursts.—Bursts of the air-chamber, if not more than four or five inches long, may be repaired in the same way as a puncture, using a very wide patch, however, and affixing it with extreme care. A burst in the outer cover may be temporarily repaired by solutioning to the lining a specially stout patch made of two thicknesses of canvas with an insertion of vellum. The cover may also require to be laced up with a large bandage, or gaiter. As soon as possible, however, the tyre should be sent to the factory.

GENERAL HINTS

Watch the winged nuts, and keep them always tightly screwed to the rims.

Wash the tyres occasionally with petrol, and examine for cuts. If deep, insert a piece of rubber and fix with solution. If the cuts have gone completely through, plug with cotton wool, and reline the cover with canvas where required. The older the tyre the more carefully must it be watched, and probable bursts prevented by interior reinforcements.

Never drive with a tyre deflated.

Scrupulously keep all wet from percolating into any part of the tyre. Whenever necessary re-enamel the rim and spoke-heads.

Also keep oil away from the tyres, or it will rot them.

Do not be afraid to pump the tyres hard, especially if carrying a full load. They should never splay more than half an inch.

Never let the car rest on deflated tyres.

In the case of wire wheels, make sure that the spoke-heads are properly covered by the tape.

Test spare tubes by inflation in water, for possible minute leakages.

Do not, however, construe air-bubbles from the valve as a sign of permanent leakage. The needle of the Michelin valve does not fit absolutely tight under the light inflation of an unprotected tube, but under full inflation in the cover may be air-proof. A good plan when tube-testing is to stop this slight leakage by moistening the needle in the mouth.

Keep all spare tubes completely deflated and away from the light. Brown paper is a good preservative. Do not wrap up two tubes together, or the pins may cause punctures.

Always carry at least two spare tubes when driving, and more if the wheels are unequal in size. Spare covers should also be carried when those in use are much worn.

Never start a journey without a pump, a lifting jack, and a fully furnished repair box. See, also, that the pump nozzle has not become detached from its socket.

At every stopping-place it is worth while to examine the covers, in case nails or flints have become embedded in the tread.

When a nail cannot be found, in case of puncture, the cover should be carefully examined for possible flints or pins.

Be sure that the wheels are strictly parallel to each other.

To determine whether a tyre is fully inflated, stand on the step and oscillate the car; the expansion of the tyre at its lowest point should be inconsiderable.

The Michelin 'cradle,' or metal nail-catcher, is a very useful device to attach to the back wheels, as it may strike off nails

before they have had time to work their way through the tread.

To reduce the probability of puncture in patches of loose stones, let the car run as much as possible by gravity, and not by driving friction.

OTHER TYRES

Various attempts have been made to produce efficient tyres for motor-cars without infringement of the Dunlop patents. At present (1904) there is only a restricted experience to call upon in respect of these new types, but the appended enumeration of their leading features is based upon personal investigations among actual users.

Since the introduction of the Michelin tyre into this country the Dunlop tyre itself has been considerably improved. The Continental tyre has also been placed on the British market. The methods to be adopted for attachment and detachment of each of these are identical with those already described in the case of the Michelin. Virtually these three tyres are of the same type, the only obvious items of difference being the valves.

The Collier.—As will be seen from the sectional illustration (fig. 15), this type is provided with an unusually stout tread, and is very durable in quality. The mode of fastening is by vertical bolts passing through a horizontal flange of metal which is shrunk on to each side of the wooden felloe. The upper ends of the bolts are ringed, and receive a wire which passes all round the bead of the cover, on each side of the wheel alike. To remove the tyre when deflated it is only necessary to unscrew the locking nuts outside the flange, and, as the wire threaded through the rings is not endless, the bolts can be pushed inwards and the edge of the cover

Fig. 15

lifted without difficulty, especially as it only engages with a flat surface, and not the turned edge of a rim of the ordinary pattern.

The Palmer.—A newcomer of note is the Palmer tyre. Its construction embodies a radical departure from the usual practice. Instead of the familiar tangential fabric of canvas, two layers of flattened cord are employed. These are set diagonally across the tread and are vulcanised into the tyre. A very light and strong cover is thus produced, free from chafing troubles and also impervious to moisture. A novel and useful device employed in the Palmer tyre is the insertion of a thin strip of red rubber in the tread. When this becomes visible through wear, it is an indication that it is time for the tyre to be retreaded.

NON-SLIPPING TYRES AND TREADS

To prevent skidding on greasy surfaces, particularly through the application of the brake, various devices have been introduced. The majority of these have been invented abroad ; indeed their use in the United Kingdom was illegal before March 10, 1904, as until the new Use and Construction Order of that date was promulgated it was required that all projections should be 'of the same material as that of the tyre itself, or of some other soft and elastic material.' The first non-slipping tyre to attract attention was the Gallus. From fig. 16 it will be noticed that the tread of these tyres is covered with parallel armatures of metal set in close series. Except for remotely possible punctures between the plates the cover is also unpuncturable ; in fact not a few non-slipping devices increase the resisting qualities of the tyre, though with a corresponding loss of resilience. In the earlier forms of the Gallus the armatures had a tendency to tear away from the rubber, but presumably the tyre has since been improved ; at any rate it succeeded in gaining the

Fig. 16

first prize in the Anti-Skid Trials at Versailles at the end of February 1904.

The Falconnet.—A method of wiring the tread of a pneumatic tyre in order to deal with slipping was introduced in 1901 by the Falconnet Perodeaud Co., of Choisy-le-Roi. As will be seen by fig. 17, the cover is full of closely set strands of crimped wire, the points of which project slightly above the tread, and thus present a rough surface to the road. It is claimed that not only is side-slipping prevented, but that the cover is also more durable and less susceptible to punctures. As to its behaviour at high speed no evidence is available.

Fig. 17

The Wilkinson.—At the Wilkinson Tyre Manufactory, Huddersfield, is made a somewhat similar tread, which can be vulcanised on to a new cover. The wires in this case, however, are straight, not crimped, and are less numerous; they are also stronger individually, and project further. The tread is made in three sections, and as the wires are worn down the rubber of the external section can be pulled away, the process being repeated after further wear. The device is remarkably effective, and permits the use of the brake on a greasy surface almost as freely as on dry roads.

The Samson.—Among the newer non-slipping attachments is the Samson tread. As will be seen from fig. 18, it takes the form of a leather band vulcanised on to the ordinary tyre. The central portion of the leather projects, with straight edges, and is also fitted with small steel studs. The tread enables the tyre to obtain a good grip on the road even when the surface is greasy, and in actual practice this form of tread has proved very satisfactory. Attachments of this kind, of course, prolong the life of the tyre proper, and thus to some extent compensate for the added cost of the non-skidding device. It is as yet impossible to say, however, how many thousands of

miles any type of tread which is vulcanised to a tyre will remain firmly attached.

The Parsons—Perhaps the most original non-slipping device is the Parsons Non-Skid (fig. 19). This is formed of a series of short curb chains which are placed diagonally over the tyre, and are coupled to a hoop on each side of the wheel. If these hoops were fixtures the device would merely provide a very bumpy wheel, and the chains would probably quickly wear through. The essential principle of the invention, however, is that the non-skid attachment is free to creep slowly

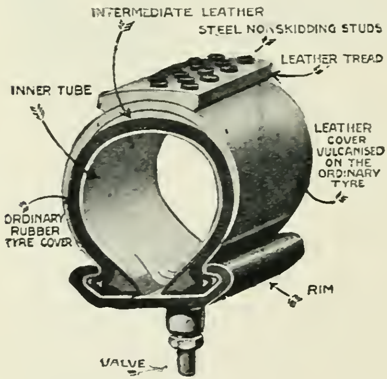


Fig. 18

Samson-Hutchinson tread

Fig. 19

Parsons Non-Skid

round as the car travels. The whole of the weight is therefore not taken by the chains, and the tyre practically lays down a non-slipping path and runs upon it. The chief recommendation of the Parsons device is the fact that the attachment is not permanent; in other words it may readily be taken off in dry weather. In the case of a puncture, of course, its removal is compulsory.

It should be mentioned that the Michelin, Dunlop, and Palmer tyres are made in patterns in which the rubber is moulded into grooves or ridges. There is also a pattern of

the Michelin into the tread of which are incorporated thin plates of metal.

SOLID TYRES

The fact that solid tyres are somewhat cheaper than pneumatics, and, of course, immune from puncture troubles, causes many automobilists to make experiments in that direction. As mentioned at the outset, however, the solid tyre is most conspicuously wanting under the very conditions when the pneumatic may seem least desirable, but is really the superior type. The problem is curiously complex. On a light, slow car, of the old Benz type, solids may safely be used ; on a light, fast car the mechanism will suffer and the passengers' comfort be affected. With a heavy car the need for solids becomes greater so far as punctures are concerned, but again the demands of the car itself and the passengers assert themselves in converse ratio. What really kills the solid tyre, however, is speed, pure and simple, quite apart from the car or the passengers. Beyond a certain maximum rate of progression several factors combine to cause the solid tyre to leave the rim. The heat due to road friction, the pressure arising from the weight of the car, and the combination of centrifugal force with the weight of the tyre itself—much greater than that of a pneumatic—all create expansion and make the tyre rise from its bed and at times fly off bodily. A tendency to creep in the rim is also caused by the non-absorbent qualities of the solid as compared with the pneumatic tyre.

Given a combination of a heavy touring car with moderate speed, the use of solid tyres is practicable; and with a very heavy car, but of low speed, they may also be reasonably employed. But when the speed exceeds twenty miles an hour the solid tyre is inadvisable for more reasons than one, whatever the weight of the vehicle itself.

Of late a tendency has declared itself to effect a compromise on large cars of fair speed by fitting solid tyres to the driving wheels and pneumatics to the front. This method ensures

facility of steering, and immunity from road shocks to the engine, and by the aid of long French springs the comfort of the passengers may be preserved, provided that the car is 'nursed' over specially rough surfaces. Even this compromise, however, has its limitations, and does not appear desirable for high-powered cars, unless the power is only used to the full on up gradients and considerably throttled down on level roads.

Fig. 20

The types of solid tyre in use are not numerous. Perhaps the best known is the Clincher. A tyre that has also been tried by a few British automobilists is the Falconnet (fig. 20), which is provided with a core of spongy rubber, and is thus somewhat less harsh than the entirely solid patterns. At speeds in excess of sixteen miles an hour, however, its security is a doubtful quantity.

In the case of solid tyres the chief essential is that a gap of a quarter of an inch should be left between the ends, to allow of expansion under heat or pressure. If this gap becomes closed in time one end of the tyre should be cut away. If the tyre be a close fit at the outset it will creep on the rim, crack at the sides, and be liable to fly off at any but slow speeds.

There are two types of solid tyre, however, in which the tendency to creep is overcome, and though, of course, they are not as comfortable as pneumatics, they may safely be adopted on the cars of all who attach especial importance to the question of freedom from puncture troubles. One of these is the Sirdar Buffer tyre, in which the rubber is under compression, and is so fitted in the rim that the greater the pressure at the point of contact with the ground, the greater is the wedging action of the attachment. There is thus no necessity to leave a gap in the rubber to allow for creeping. The second tyre referred to is the De Nevers, which is made with transverse slots at intervals of three inches. The expansion due to weight pressure is thus confined to each section in turn.

CHAPTER XII

STEAM CARS

BY H. WALTER STANER, EDITOR OF 'THE AUTOCAR'

A STEAM car, although driven by a steam engine, really derives its power from heat, but, instead of the source of heat being burned and converted into power in the cylinder of the engine, as in the internal combustion engine of the petrol car, it is burned under a boiler. The expansive or elastic force of the steam pressure generated by the heat of the fire in its turn drives the engine, which gives the car its motion. The heat energy of the fuel is released by combustion ; this heat is used to generate steam in the boiler, and the energy of the steam is transformed into motion after being admitted into the engine. Thus the three main essentials of the propelling apparatus of a steam car are the fire or burner, the steam boiler or generator, and the engine.

Fuel.—Coal or coke is not used for pleasure cars, as both are too cumbersome and dirty, and the fire requires constant attention, liquid fuel in the form of petroleum (paraffin), or petroleum spirit (petrol or motor spirit), being universally adopted. Although petrol will ignite instantly if a match be applied to it, and paraffin will not, both must be vaporised or transformed into a gas by heat before they can be economically and cleanly used as heating agents. Not only so, but when vaporised, they must be burned mixed with air on the Bunsen principle.

Petrol Burners.—Assume for a moment that the petrol for the burner has been vaporised by a method to be described later and transformed into gas, which we will for the future call

'vapour.' The Locomobile burner, fig. 1, takes the form of a shallow circular metal box of slightly less diameter than the boiler under which it is placed. There are 107 half-inch tubes, which pass through the bottom and top plates of the box. In the top plate twenty small holes are drilled round each of the half-inch tubes, and as the vapour is injected into the box through the pipe A it passes up these small holes round each of the air-tubes, mixed with the air continually sucked in with it as it enters from the vapour nozzle, and it issues from the twenty small holes round each air-tube, and burns with a solid blue flame above the top plate of the burner, the air for combustion of the mixture (air and vapour) being supplied through the 107 half-inch air-tubes. The tube A at the side of the burner, which is

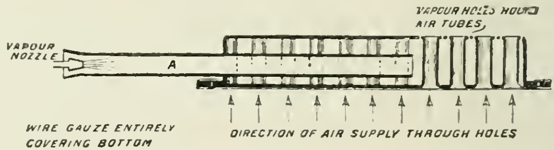


Fig. 1.—Section of the Locomobile type of Burner

about one inch in diameter, is open at the outer, as well as at the inner end, so that the vapour which is injected into it induces a continual flow of air with it into the burner. The end of the pure vapour tube which projects into the induction tube A is called the nozzle or nipple.

Vaporising the Fuel.—The petrol is forced from the petrol tank to the burner by air pressure, a cylindrical air vessel is connected with the petrol tank, and it is pumped to about 45 lbs. pressure in the Locomobile and most cars of similar type. The pressure is obtained by means of an ordinary bicycle pump, and it occasionally requires a few strokes of the pump to maintain it as the petrol is used up. An air-pump driven by steam can be fitted to all steam cars, so that the hand-pump need not be used. To vaporise the liquid, it is passed by means of a tube up through the boiler across the top of it, and down again through another tube, the heat of the

boiler being found sufficient to transform the liquid into gas. Thence it passes into the burner. This is the Locomobile arrangement. In the Weston the petrol is pumped through a tube which runs straight across the fire-box, the heat

M. Serpollet on his first Steam Tricycle (coal-fired) (date 1887)

vaporising it. It will be seen that these methods, which are mentioned as examples, all require that the burner shall be in operation before the process of vaporising can be commenced, and as the burner can only consume vapour, some additional method is necessary to obtain the initial heat.

Starting the Burner.—The Weston starting apparatus is fed

by a separate tube from that which supplies the main burner. Its working is as follows :—The tap A, fig. 2, is opened so that the petrol flows through the tube F, and by opening a small tap B the spirit runs into a little square box, outside the fire-box, by the pipe F^1. In this box, G, is a small cup, which as soon as it is quite filled the tap B should be turned off. A match is then applied to a hole in the side of the box G, and the petrol in the small cup lighted ; it burns under a tube of Γ shape filled with copper borings and heats it and them. This Γ tube has a tap C to it, so that petrol can be injected through it, and when it is heated the petrol, as it percolates through the hot copper borings, is vaporised. As soon as the petrol in the cup is nearly burnt out, the tap C is turned on, admitting petrol from the pipe F into the Γ tube burner above the cup. The flame of the petrol left in the cup lights this 'pilot burner,' and it projects its flame on

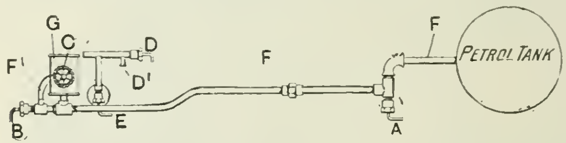


Fig. 2.—The Weston Apparatus for Starting the Burner.

to the vaporising tube across the fire-box, which supplies petrol to the main burner. When this is believed to be heated sufficiently to vaporise the petrol it can be tested by turning on the tap D, when, if the fuel is not vaporised, liquid will issue from the tap D^1, and a minute or two longer must elapse before the main burner can be started. As soon as gas is found to issue from D^1, E is slowly opened, and this admits the vapour into the main burner. It issues into the fire-box, and is ignited by the pilot light. As the heat increases the petrol tube across the fire-box becomes sufficiently hot to vaporise the full supply of fuel, and steam is raised. The pilot light burns continuously, so that when running down-hill or when leaving the car, the main burner can be turned right out ; as the pilot light is always burning the burner can be relighted instantly as soon as petrol is turned on again.

A Cremorne Steam Car

The Automatic Fire Regulator.—Many steam vehicles are fitted with an automatic fire regulator, of which one is taken as an example, it being the same in principle as most others. Fig. 3 is a section of the device. A diaphragm or circular plate is pressed by the steam from the boiler, and as the pressure rises the diaphragm is, so to speak, bulged. In its turn it pushes the plunger rod, which has a

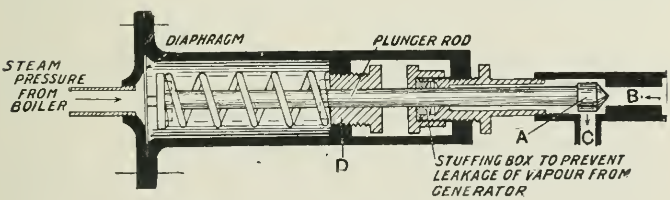


Fig. 3.—Automatic Fire Regulator

conical head A, forward, so that it closes or partially closes the end of the tube B, through which the vapour passes into the tube C on the way to the burner. When there is no pressure in the boiler the coil spring round the plunger rod holds it back, so that the orifice closed by A is fully opened and the vapour passes freely into C and on to the burner. As steam pressure rises the diaphragm is gradually bulged, so that

A begins to close on to B, and at a predetermined pressure, obtained by adjusting the screw D, it closes B entirely, which only commences to open again as pressure falls. When no constantly burning pilot light is used, there is a small groove cut in the opening B, by means of which enough vapour is admitted to keep the main burner just alight. In some cars no automatic regulator is used, the fire being controlled entirely by the driver from the seat. It should be understood that although the automatic regulator prevents vapour passing to the burner when a maximum predetermined pressure of steam in the boiler is reached, there is always a tap handy to the driver which enables him to turn off the supply of fuel at any time.

The White Thermostat Regulator.—A distinctive feature of the White car is the thermostat arrangement which regulates the amount of fuel passed to the burner. This, as its name denotes, effects the control of the fire from the amount of heat generated, but in this case the heat required is not obtained directly from the fire, but from the superheated steam from the generator. In an extension of the last and bottom coil in the generator is placed a copper rod, one end of which is fixed while the opposite end is passed through a steam-tight opening in the end of the tube. As the temperature of the steam increases, this copper rod expands and actuates a crank to one arm of which is attached a valve controlling the amount of liquid fuel passed to the burner. In operation it is found that a change of temperature equal to 15° F. will actuate the controlling valve. As the increase of temperature leads to the cutting down of the fuel supply it follows that the heat from the burner will be reduced, and so in its turn the temperature of the superheated steam. From this it will be seen that the regulation of the fire is very nicely balanced and requires no attention from the driver of the car; for so long as the temperature be below a predetermined point the burner is in full operation, and it is only when the generator is liable to overheat and produce more steam than is required that the apparatus comes into operation.

Paraffin Burners.—For burning paraffin instead of petrol, burners of a somewhat different description are employed, as paraffin requires more heat to vaporise it sufficiently, and when vaporised a larger supply of air is necessary for complete combustion. If these conditions are not obtained, a paraffin burner will smoke and give off insufficient heat. Clarkson's paraffin burner is shown in fig. 4. In this the paraffin is forced by air pressure through the vaporiser, which takes the form of a coiled pipe above the flame of the burner. It then passes through the vapour pipe to the jet nozzle, and air is admitted by the door of the mouthpiece, and mixes with the paraffin vapour, which rushes along the inducing-tube and issues from the circular opening below the cap, where it ignites so that a spreading ring of flame is formed, which jets out all round the coiled ring of nickel wire shown in the figure; this and the shape of the circular trough tend to spread the flame, so that it completely covers the bottom of the boiler. The intensity of the fire is regulated by a control lever connected to a handle by the side of the seat, and it will be seen by examining the connections at the bottom of fig. 4 that the needle which increases or decreases the size of the hole of the jet nozzle, by which the vapour enters from the vapour-pipe into the inducing-tube, also proportionately raises or lowers the cap, so that the opening of the burner itself around the cap is proportionately adjusted in size. Air is supplied by suitable holes in the bottom of the fire-box. To obtain the initial heat, methylated spirit is poured into the circular trough and lighted, thus heating the vaporiser, or when gas is laid on in the stable a flexible tube and gas-jet can be used. The primary reason that the vapour from the jet nozzle flows up the inducing-tube is because the heat of the fire-box induces a constant inward current of air through the open door of the mouth-piece. No automatic regulator is fitted to this burner, which in the usual way is controlled entirely from the seat, but the makers have designed a special form of diaphragm regulator, which is sometimes used. When the burner is applied to a flash boiler, a regulator is

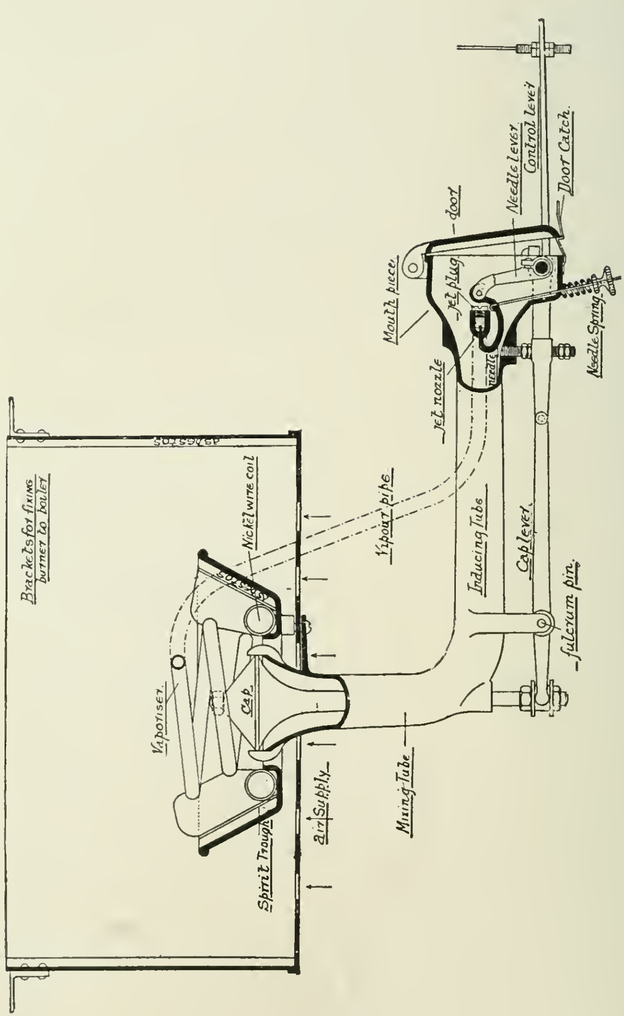


Fig. 4.—Section of Clarkson's Paraffin Burner

employed ; this is called the thermo regulator, and by it the supply of vapour to the burner is automatically controlled by the temperature of the superheated steam. For explanations of ' Flash boiler ' and ' Superheat,' see ' Boilers.'

The Serpollet burner shown in fig. 6 has a number of small atmospheric burners, and the paraffin is vaporised by being pumped through a tube placed across the fire-box before entering the burners. The initial heat is obtained by a gas-flame, or by burning alcohol in a tray under the vaporising tube. The burners are concentric ; the vapour passes up a central tube surrounded by two air-tubes, and the suction of the vapour draws air up these, and it mixes with this air before burning.

In the Turner-Miesse system initial heat is given to the vaporising tubes by means of a blow lamp such as house-painters use for removing old paint. A tray is provided outside the fire-box on which the lamp is placed, with its nozzle projecting through an orifice so arranged that the flame is directed upon the first vaporising tube. The vapour is led to a chamber where it mixes with air to form a combustible gas which is consumed at a number of tubes placed across the bottom of the fire-box. The burner tubes are of circular section pierced with two rows of small holes at such an angle that the jet of flame proceeding from a hole in one tube meets a corresponding jet from another tube, and in this way the flame is caused to spread over the largest possible area. In order to arrest the carbonaceous and tarry deposits from the vaporised paraffin the mixing chamber is lined with wire gauze which may be removed for cleaning or replacement. In addition to this a U bend is connected to the vaporising tube by means of union nuts, and this primarily collects all deposits of vaporisation ; it is placed in such a position as to be readily changed for a clean tube when necessary.

The Boiler.—We have seen how the mission of the burner is to supply heat to the boiler, and how that heat is generated and controlled ; the next step is to consider the generation of steam in the boiler.

The duty of the boiler is to supply high-pressure steam to the engine. Steam is the gas which water gives off at boiling point, 212° Fahr. High-pressure steam is steam which is confined in a space smaller than that which it would occupy at atmospheric pressure. The smaller the space in proportion to the volume of steam, the greater the pressure. Steam so confined has immense elastic and expansive force, and the boiler and burner are so proportioned that when the pressure of steam is once obtained, the continual generation of it is so

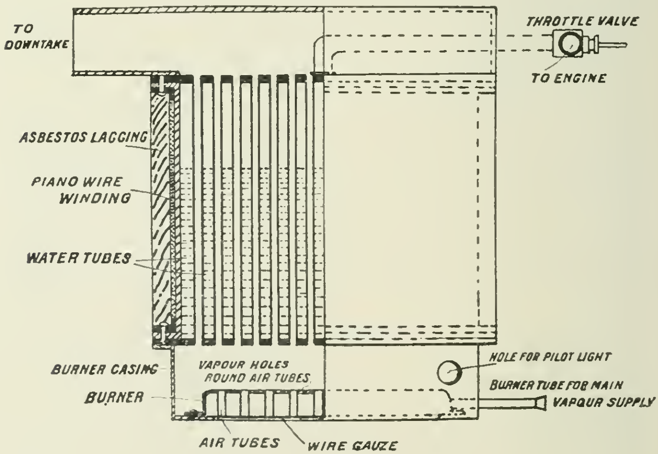


Fig. 5.—Section of a Multitubular Boiler with Main Burner in Position

rapid that, although the engine be using it up all the time, pressure is maintained.

Fig. 5 is a sectional drawing of a multitubular boiler. The boiler is a cylindrical vessel or drum of copper, which should be kept rather more than half filled with water. Through the boiler some three hundred half-inch copper tubes run, so that heat from the burner, after heating the bottom of the boiler, passes up these tubes, heating the water in the boiler. It will be seen that the barrel of the boiler is strengthened by winding

with steel wire, which is closely coiled around in the same way that a gun is wire-wound. The rough coating of asbestos, or lagging, as it is called, is held to the boiler by thin metal bands. Its mission is, as far as possible, to prevent the escape of heat, as any loss of heat means that more fuel must be burned to maintain steam.

As the heat passes up the boiler tubes, after heating the bottom of the boiler, the water is heated and boiled, and the steam rises, filling the space between the water-level and the top of the boiler. This space is very much less than the steam would naturally occupy, and, consequently, pressure soon becomes high. The heat from the fire in the boiler tubes not only boils the water around the portion of each tube surrounded by water, but in the upper part its heat tends to dry the steam and keep it from being too wet for satisfactory use in the engine.

The hot gases then pass into a box on the top of the boiler, called the 'smoke-box,' and thence into the down-take or chimney projecting below the car. The steam from the boiler passes along the pipe to the throttle-valve to the engine, the handle of which is by the side of the driver, and as this throttle is opened or shut, steam is admitted or shut off from the engine. The type of boiler we have been describing is fitted to some of the smaller and lighter steam carriages, though in the majority of cases steel enters more largely into the construction of the boiler, so that the wire winding is not used.

Boilers with tubes surrounded by water, up which the heat of combustion passes, are known as fire-tube boilers, and are the same in principle as those used on a railway locomotive, though in the latter case the boiler is horizontal, instead of vertical. There is another type of boiler that is largely used on steam lorries and other heavy steam automobiles, which is known as the water-tube type. In this the water is contained in tubes, which the fire surrounds—the exact opposite to the arrangement in the fire-tube boiler.

The Flash Boiler.—All fire-tube and water-tube boilers

carry a considerable quantity of water, but the flash generator is not a boiler at all in the ordinary sense of the word, and contains practically no water. So far as steam generation is concerned, the principle of the flash boiler may be likened to dropping water on a red-hot iron. A small stream of water is pumped through a coil of steel tubing, and this tubing is heated to an intense heat by the burners, so that almost as soon as the water enters it, it is 'flashed' into steam—that is to say, the process of boiling and steam generation is all gone through in an instant, and the water which enters the coil of tubing at the bottom issues from the top of the coil as high-

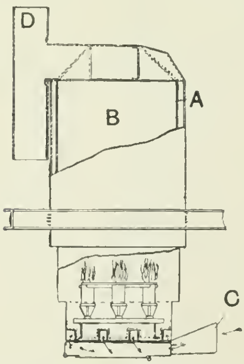


Fig. 6.—The Serpollet Generator with burners below

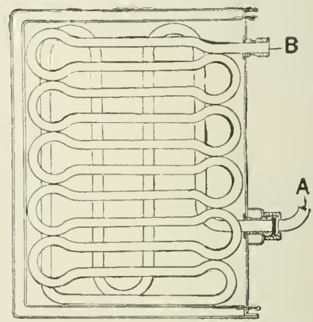


Fig. 7. Plan of Serpollet Generator, showing arrangement of coils

pressure superheated steam. This process goes on continually as long as the water is pumped into the coil, as its quantity is always small compared with the length of heated tube.

Figs. 6 and 7 illustrate the Serpollet generator and burner, the latter being dealt with under 'Burners.' The generator consists of a box with an outer and inner metal skin packed with asbestos to retain heat. Coils of round nickel steel tube are placed within this box, and fig. 7 is a plan of one of these coils. The coils are placed one above the other and vary in numbers, according to the power of the engine they are

required to drive. They are connected to each other by D tubes, these junctions being outside the burner space, so that they do not get the direct heat of the fire upon them. It will be understood that these coils are arranged like shelves inside the generator case A (fig. 6) in the space B, with the burners giving off their heat below. The burners quickly bring the coils to a red heat, and a small stream of water is pumped into A (fig. 7), and almost instantly converted into steam. It passes right through the coil, issues at B into the next coil above, and so on to the engine. The upper coil superheats the steam—that is to say, it makes it very much hotter than it would be in that type of boiler we have previously described—as after being converted into high-pressure steam in the lower parts of the coils, it is still subjected to great heat in the upper lengths of the coil before it passes to the engine. The expansive force of the steam is considerably increased by this superheating, and not only so, but it is very different from the steam generated by a fire-tube or water-tube boiler, being much drier, as well as hotter. C (fig. 6) indicates the air-inlet to the burner box, and the arrows show the direction of the air currents. D is the chimney.

The boiler of the Turner-Miesse car is also of the flash type, consisting of a pile of weldless steel tubes bent into grid shape. Instead of the grids being connected, as with the Serpollet generator, in series, they are arranged so that the water tubes and superheating tubes are most efficiently spaced.

The White generator consists of a number of weldless steel tubes formed into a series of coils placed one within the other and enclosed in a circular box of sheet steel lined with asbestos. The water from the pump passes around the top coils and in its descent is 'flashed' into steam at about half the entire length of the coils. During its passage through the remaining coils the steam is superheated, or, as it may almost be termed, 'extra gasified,' to such an extent as to prevent its condensation in the engine cylinders, yet not sufficiently to

cause it to burn the valves or working parts. It may be here explained that condensation by contact with surfaces at a lower temperature than the steam itself leads to a loss of power through the steam becoming less expansive.

Pumps.—When steam is up, and the burner in full operation, the water in the boiler is quickly evaporated, and the renewal of the supply is performed by pump. The pump is usually driven off the cross-head, a part of the engine which has a constant up-and-down motion. On many of the older cars the water supply was carried in a horseshoe-shaped tank at the back, which half encircled the boiler. In the Serpollet the water-tank takes the place of the motor bonnet of a petrol

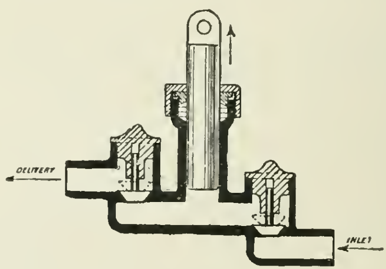


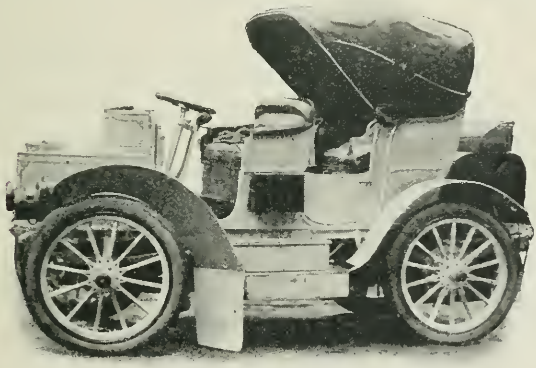
Fig. 8.—Pump with Conical Valves

car. The Turner-Miesse carries its water supply in a tank beneath the rear part of the car.

The pump, fig. 8, has a tightly fitting plunger, which is pulled up and pushed down by the engine. As it makes its upward movement it sucks water in on the right, and the valve, which only opens in an outward direction, freely admits the water. As the plunger is pushed down it compresses the water which at once closes the valve on the right and opens the one on the left, forcing the water to the boiler. The valve on the left is opened by the pressure of water from the pump and closed by the pressure of steam on the other side from the boiler as soon as the down-stroke of the pump ceases.

Before the water from the pump enters the boiler, it is

usually passed through a coil of tube inside the exhaust muffler, which is a cylindrical case, into which the exhaust steam from the engine is passed before escaping into the chimney. The expansion of the steam in the silencer reduces the noise of the exhaust, and the steam with which it is filled heats the coil through which the water from the pump passes to the boiler, so that the water itself is partially heated when it enters the boiler. This, of course, means that less heat is required from the burner to keep up the pressure of steam. The pump is at work the whole of the time the engine is run-



A 12 h.-p. Serpollet Touring Car (date 1901)

ning, so when the engine is requiring little steam the pump would overflow the boiler, and to obviate this a two-way cock or tap is interposed between the boiler and the pump, controlled by a handle near the driver's seat, by which he can turn the water from the pump back into the tank. A separate hand pump is fitted for filling the boiler for starting, or at any time when it requires more water when the engine is not running, but a steam pump is frequently fitted so that steam once 'up' hand pumping need not be resorted to.

We have already shown that in many cars the forcing of the petrol supply to the burner does not require a constantly acting

pump, as an air-tank occasionally pumped up by hand provides enough pressure to force the petrol through the vaporiser to the burner, but in the Serpollet the paraffin (which is under air pressure) was also pumped to the burner as well as the water to the generator. The arrangement is shown at fig. 9. It has been found that six parts of water require one part of paraffin to vaporise them in the Serpollet. The oil pump O is smaller than the water pump W, and both are connected by links O^1 and W^1 to the lever L, which hinges on the fulcrum D. The lever L is moved up and down by the link L^1, which is con-

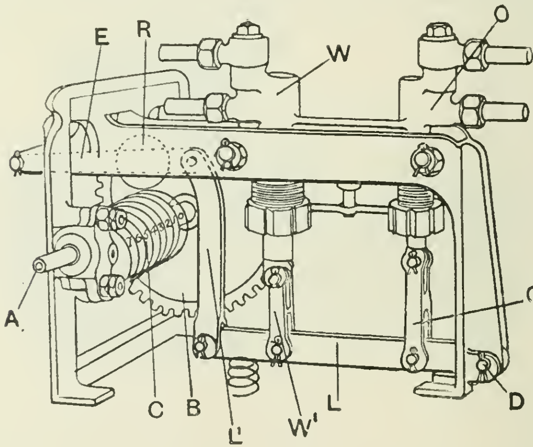


Fig. 9.—The Serpollet Water and Oil Pumps

nected to the arm E. On the arm E is a roller R, which is forced up and down by eccentric discs or cams C on the shaft A, which is rotated from the engine by the toothed or cogged wheel B. The result is that, as the lever L is hinged at D, its up and down motion is greater at W^1 than at O^1, so that the water pump W always has a longer stroke than the oil pump O.

When more steam is required in the Serpollet, it simply means that more water must be forced into the heated generator

coils by the water pump. At the same time the greater supply of water requires a larger supply of oil to the burner to keep the coils hot enough to evaporate it, and the stroke or up-and-down motion of the lever L can be varied by shifting the shaft A sideways, so that cams of varying degrees of eccentricity can be brought under the roller R, and its motion increased or decreased as required. As the two pumps are both connected to the lever L, it will be seen that whether they are giving full supply or anything below it the proportion of six parts of water to one of oil will always be maintained. On some Serpollet cars the pumps are horizontal instead of vertical, but they operate in a precisely similar manner.

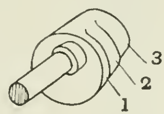


Fig. 10.—Example of Cams of Different Throws

Fig. 10 shows three cams in a row. These cams are eccentric discs fixed on a revolving shaft, and as the faces of Nos. 2 and 3 do not project so far from the shaft as 1, if the roller R be introduced against the face of 3, for instance, it will be moved up and down less than if it were bearing against the face of No. 1; so that all the driver has to do when he wishes to increase or decrease the steam supply to his engine is to shift a lever by the seat; this moves the shaft, on which there are eight cams (fig. 9) of varying eccentricity, when the stroke of his pump will be proportionately altered. It should be added that the roller R is kept down on to the cams by a spring, which will be noticed under the lever L (fig. 9). In the 1904 cars this mechanism has been abolished and a simpler arrangement substituted. The petroleum feed-pump has been abandoned, and a pressure of about $2\frac{1}{2}$ lbs. per square inch is now maintained on the surface of the oil in the fuel tank.

On its way to the burner the oil passes through a distributing box; this box is made with a number of little holes which can be uncovered or covered by a slide worked by the driver. When this slide is in its extreme shut position there is one small opening only, and this is just sufficient to keep the burner alight. When the slide is in the three intermediate

positions the burner is supplied with fuel in strict accordance to the power required. A similar box alongside the oil distributor and having also a slide has its openings so proportioned that the fuel and water feeds are exactly correct to ensure the best results. The two slides are regulated from a single lever, so the driver simply moves this lever to the requirements of speed and power from the car.

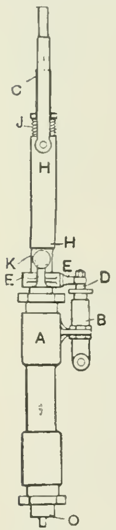


Fig. 11.
The Simpson oil and water pump

In the Simpson, a car well designed and built but little known, which was fully described in 'The Autocar' of January 16, 1904, the feed control is designed to maintain automatically under all conditions a steady steam pressure in the instantaneous generator. Referring to the drawing (fig. 11), A and B are the pumps delivering feed water and fuel to the boiler and burner. C is a continuation of the water pump plunger and forms a guide rod to steady it. D is the oil pump plunger, and this is attached to a crosshead E E, so that both pumps operate together. Surrounding the guide rod C is a strong steel spring which is incased in the sleeve or chamber H. This sleeve has upon its outer end a nut J for the purpose of putting compression upon the spring, the other end of which abuts against a collar forged upon the guide rod C. The sleeve is provided with a lip, engaging with the collar before mentioned, on the outward or suction stroke of the pumps. An eccentric rod driven from the rear axle of the car is connected to the sleeve H, and imparts the necessary motion to the pumps. Mounted upon and forming part of the crosshead E E is a bracket carrying a rod, which is provided with a shoe-piece K at its lower end. This shoe-piece is normally held up close to the bracket by a spring. Connected to this is the hand pump lever operating the pump for starting purposes.

The action of this device is as follows: Having adjusted

the compression nut J to the required boiler pressure, the supply of water and oil is then controlled automatically by the pressure in the generator acting upon the spring which is interposed between the actuating eccentric and the pumps. This spring being set to a predetermined pressure of, say, 400 lbs., will remain rigid until that pressure has been reached in the boiler, when by increased resistance on the water plunger the spring will compress and absorb part of the stroke or throw of the eccentric, and therefore part of the travel of the pump plungers. This action goes on continuously, and the travel of the pump is exactly in accordance with the demand for steam from the boiler.

If, on descending a long incline, the throttle valve be entirely closed, the spring will then absorb the entire travel of the eccentric, and the plungers will cease to reciprocate. Immediately the throttle is reopened and the boiler pressure tends to fall, the compression of the spring at once ceases, and the pumps again deliver the required quantities of water to the generator and oil to the burner.

Referring now to the bracket on the crosshead E E: This bracket moves with the plungers C and D, and carries with it the shoe piece K, which can be lowered down to the pump rod by means of a pedal from the driver's seat. The lowering of this shoe-piece at once renders the whole connection rigid, and cuts out the action of the spring. This is found invaluable should a stiff gradient be encountered, when a boiler pressure beyond the setting of the spring can then be attained for a short time. On releasing the pedal the shoe-piece rises at once to its normal position by the spring on its upper end. This shoe-piece cannot, of course, be inserted for long periods together, otherwise flooding of the burner and boiler must take place. The whole device is placed at the right side of the car beneath the frame, and is thoroughly accessible. It is driven from the rear live axle by an eccentric.

Water Gauges.—All fire-tube and water-tube boilers, i.e. all boilers in which any appreciable quantity of water is carried,

are fitted with a water gauge, as they are not sufficiently thick to resist damage from burning should the water level be allowed to become so low that the tubes and tube plate become unduly heated. A water gauge is to all intents and purposes a glass window in the boiler. It takes the form of two taps, one below the water level, and the other above. These two taps are connected by a glass tube, provision being made to prevent leakage where the glass joins the taps. In some steam cars, as the boiler is out of sight of the driver, under the seat, tubes are provided so that the water gauge can be placed nearer to him, and a looking-glass is fitted on the dashboard, reflecting the gauge to the driver's eye.

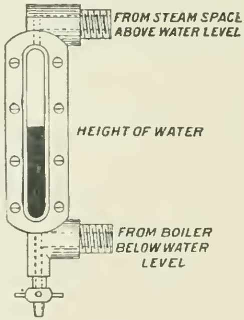
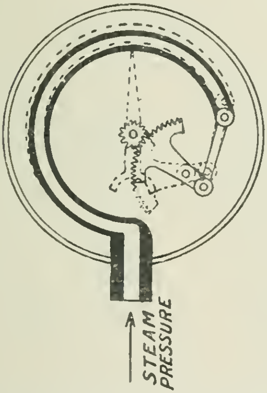


Fig. 12.—The Klinger Water Gauge

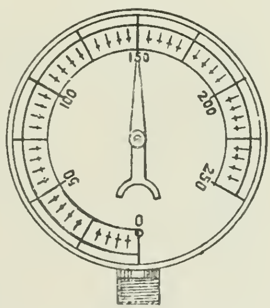
The Klinger gauge (fig. 12) is a great improvement on the ordinary type, as it is provided with a glass window of prismatic section, and the result is that the water is shown black, and its height is much more easily read than with the ordinary glass gauge-tube. Should the driver have reason to doubt the accuracy of his gauge, he can test it by opening the tap at the bottom. All water gauges have a similar tap.

Pressure Gauges.—Pressure of steam in the boiler is expressed in this country in pounds to the square inch, and

a small instrument known as a steam pressure gauge is used for the purpose. This is connected to the boiler by a pipe and is fixed on the dashboard in front of the driver, and a hand on the dial indicates the steam pressure in the boiler (fig. 13). The interior mechanism of the gauge is extremely simple. It consists of an oval tube bent in a loop, as shown. One end is open to the steam pressure of the boiler, and the other end is closed, the closed end being attached to a short arm, which moves a rack engaging with a small toothed wheel



Steam pressure Gauge with face removed and Bourdon Tube in section



Steam pressure Gauge, ordinary appearance

Fig. 13.

behind the dial, and so turning the hand on its face. The gauge depends for its working on the fact that a bent tube, when subjected to internal pressure, tends to straighten itself out.

The Engine.—Having seen how the heat is supplied by the burner and steam by the boiler, we turn to the engine. This description of the engine need not be read by the novice unless he likes, as it deals with a portion of the car which is quite automatic, and which is exactly the same in its operation

as the engine of that most reliable automobile—the railway locomotive. Most steam cars have two cylinders, but for the sake of simplicity we will describe a single-cylinder engine, as the principle of working is identical. Fig. 14 shows the cylinder A, in which a piston B is free to move up and down. The steam is admitted alternately at the top and the bottom of the cylinder by means to be described later. To the piston B a piston-rod C is fixed, and it issues through a hole in the bottom of the cylinder. Both the piston B and the hole through which the piston-rod issues from the cylinder are rendered steam-tight by means to be presently described. The piston-rod C is attached by a hinged joint D to the connecting rod E, which at the other end encircles the crank-pin F of the crank G, which moves, as shown by the arrow and dotted line, in a circle of which H is the centre. We will assume that steam is admitted to the top of the cylinder A. It forces the piston B downwards, which in its turn depresses the piston-rod C, and, as this is connected to crank G by the connecting rod E, the rotation of the crank is started. Just before B gets to the bottom of the cylinder, the steam supply on the top of it is stopped, and steam is admitted underneath the piston, so that it is forced upward from the underside, and the crank is pulled up. As B ascends it expels the steam from the cylinder which had driven it on its downward stroke. This action is kept up as long as the engine is at work, and by the interposition of the connecting rod and crank, the reciprocating or

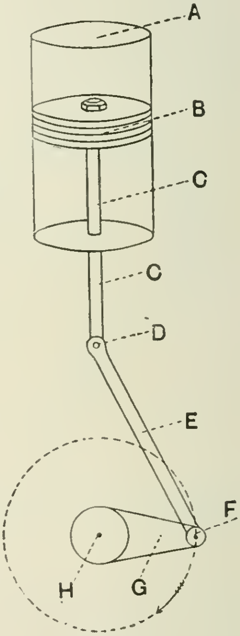


Fig. 14

to-and fro motion of the piston is transformed into rotary motion.

The Slide Valve.—The admission of the steam at alternate ends of the cylinder, and its outlet after it has forced the piston down or up, is controlled by the slide valve, which is worked by the crank-shaft of the engine. Figs. 15 to 18 show the slide valve and piston in different positions, and figs. 19 and 20 give details of the steam ports, exhaust port, and slide valve. Steam ports S P, or openings, are made at the top and bottom of the cylinder, fig. 15, and these are shown in plan at fig. 19. Between them is an opening E P, the exhaust port and the slide valve S V, which from fig. 20 it will be seen

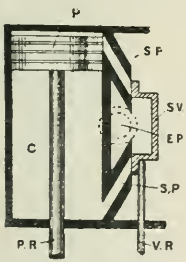


Fig. 15.—Piston at top, valve closed, just about to open

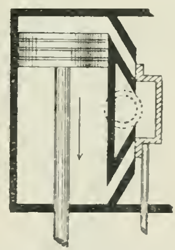


Fig. 16.—Valve open a little; piston descending

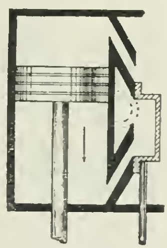


Fig. 17.—Valve full open

is a hollow box, alternately covers and uncovers the steam ports for admitting steam to the piston. While it is doing that for one end of the cylinder it is connecting the other steam port with the exhaust port, so that the steam, after it has done its work, can escape freely.

We will assume that the engine is running, and at fig. 15 the piston P in the cylinder C has reached the top of its stroke. At this moment the top steam port is closed by the edge of the slide valve, but as the piston commences to descend on its return stroke, the slide valve has also moved downward, so that the steam is admitted to the top of the piston and forces it downward, as shown in fig. 16.

In fig. 17 the piston has descended further, and the top steam port is fully open to it, but as the slide valve has also descended further, the bottom steam port is open, and the steam which had forced the piston upward in the previous stroke is now, having done its work, pushed out by the descending piston through the bottom steam port into the box portion of the slide valve, and as it will be seen that this is also open to the exhaust port, the steam passes away to the chimney.

In fig. 18 the piston has reached the bottom of its stroke, and is just commencing to ascend, steam being gradually admitted to the bottom steam port while the top steam port is

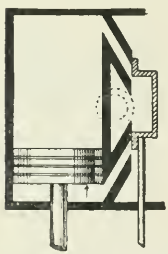


Fig. 18.—Valve open to bottom of piston; piston ascending

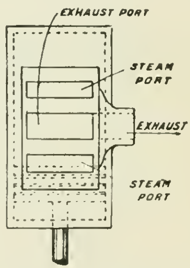


Fig. 19.—View of Valve face and exhaust outlet at side

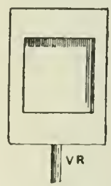


Fig. 20.—Plan View of Slide Valve

being opened by the upward movement of the slide valve, so that the steam on the top of the piston can escape into the exhaust. These actions are continued while the engine runs, and as we have already seen how the up-and-down motion of the piston turns the crank, it is necessary for us to find out how the slide valve is moved backward and forward, so as to perform the operations we have described at the proper time with relation to the piston.

Figs. 21, 22, and 23, although mainly for another purpose, will also show how the slide valve is operated. Fig. 23 shows the position of the valve when the engine is running forward. Two eccentrics are keyed to the crank-shaft. These two

eccentrics F E and B E are circular discs; they are not, however, fixed to the shaft at their centres, but eccentrically. As the shaft revolves, they have an up-and-down motion, practically the same as if they were cranks. A ring encircles each eccentric, so that the eccentric itself is free to revolve in the ring. To the ring the eccentric rods F and B are fixed. At the other end the eccentric rods are connected on working joints to a curved link. In the curved link is a block B, which has a free sliding fit, and this is connected to the slide valve rod V R in figs. 15 and 20, and plainly shown in figs. 21, 22,

Diagrams for link motion

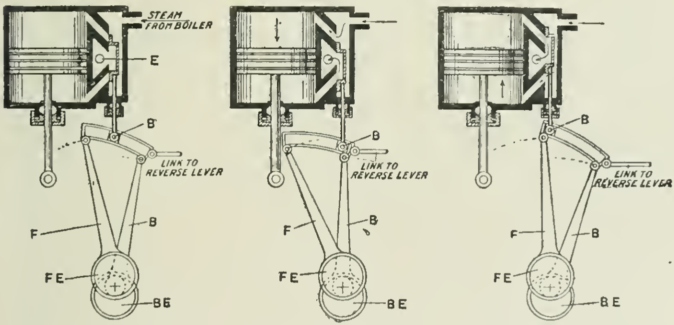


Fig. 21.—Mid Gear: no steam

Fig. 22.—Backward Gear: steam at top

Fig. 23.—Forward Gear: steam at bottom

and 23. As the engine revolves the eccentric gives an up-and-down motion to the rods which are hinged to the link. If we look at fig. 23 it will be seen that the forward eccentric rod is nearer to the slide valve rod than the backward eccentric, and this results in an up-and-down motion of the slide valve being produced by the forward eccentric F E, as the backward eccentric B E only forces the right-hand end of the link up and down, and does not drive the slide valve. In fig. 21 we see that by the link connected to the reverse lever by the side of the driver the curved link connecting the two eccentric rods to the slide valve has been so moved that the slide valve

rod is placed in the middle of the link. As the engine revolves the eccentrics simply push each end of the link up and down alternately, giving practically no motion to the slide valve, but by moving the reversing handle so that the curved link takes position somewhere between those shown on fig. 23 and fig. 21, the travel or distance which the slide valve moves up and down is reduced, so that the steam is cut off from the piston before the end of its stroke. This process is known as 'notching up,' and it simply means that the steam, instead of being admitted to the piston almost to the end of each stroke, is cut off before the stroke is completed, the expansion of the steam being sufficient to finish the working stroke. This results in a distinct economy in steam, and is one of the first things which a driver of a steam car should learn to do, for it is often unnecessary when running fast on the level or down slight slopes to drive with the steam admitted right to the end of each stroke. This results in economising the steam, which in its turn means that less fuel is used. The backward and forward eccentrics are so set with relation to the crank that the steam is admitted and released at the proper time. When running forward, the forward eccentric does all the work of moving the slide valve up and down, and when running backward the backward eccentric performs it. In other words, the eccentric rod nearest the slide valve rod is the one which works the eccentric, and when we get into the position of 'mid gear' (fig. 21) no steam is admitted at all, as both eccentrics are working the link up and down, but not moving the valve, the block B occupying the same relation to the curved link that the boy does to a see-saw when he stands in the middle of it. The box on the side of the cylinders, in which the slide valve works, is known as the 'steam chest.' The arrows show the passage of the steam from the boiler into the cylinder and out of it, E, the exhaust outlet, being marked for clearness in fig. 21. Although we have spoken throughout as if the eccentrics were so set in relation to the crank, and the slide valve so proportioned that the steam was all pushed out

by the piston when exhausting, it should be understood that the exhaust port is closed just before the piston reaches the end of each stroke, so that a small quantity of steam is what is called 'trapped' in the cylinder. This serves as a cushion, and prevents the reversal of the direction of the piston being accompanied by any shock. We do not go into the mysteries of 'lap and lead,' as they are matters which the manufacturers of steam engines satisfactorily settled long ago, and the automobilist need not trouble himself concerning them.

Anyone who is absolutely unacquainted with link motion and steam engines generally should, if he wishes to get an insight into the working of an engine, spend a quarter of an hour examining a small model steam engine. He will learn more of its working—which is very simple in itself, though laborious to plainly describe—in five minutes than he can from as many hours of reading. It should be understood, with regard to figs. 21, 22, and 23, that the link motion is shown at right angles to its true position, as, while we have an end view of the cylinders and slide valve, we have a side view of the links and eccentric rods, this distortion occurring merely for the sake of clearness. Nor are the eccentrics fixed quite at right angles to the crank, but to explain this would occupy more space than we have at our command.

Compound Engines.—The compound engine employed on motor-cars is usually a two-cylinder one, but it is so arranged that one cylinder receives high-pressure steam from the boiler, and, instead of the exhaust being passed away into the chimney, it is turned into the second cylinder and drives the piston in it before being released. The high-pressure cylinder is smaller in diameter than the low-pressure cylinder, which is of such diameter that the power from the low-pressure cylinder is practically equal to that of the smaller high-pressure cylinder. For starting purposes, or when special effort is required, the driver can turn high-pressure steam into both cylinders. The idea of the compound engine is economy of the steam consumption, as more work is got out of the steam before its

final release. Linking up, or using the steam expansively in an ordinary or simple engine, is done with the same end in view.

The White Engine.—The best example of the compound engine in an automobile of the present day is to be found in the White car. This has two cylinders, high and low pressure, with the usual arrangement for admitting high-pressure steam to the low-pressure cylinder. In this engine all the working parts, such as the crank shaft, eccentrics, guides &c., are enclosed in an aluminium crank chamber which not only renders such parts proof against the incursion of dust but enables the working parts to run in oil. Ball bearings are fitted to the crank shaft and all the principal bearings. The ordinary slide valve and gear as previously described are employed in this engine.

The Serpollet Engine.—This engine is designed to use highly superheated steam, and is entirely different from the ordinary steam engines which we have just described.

The Serpollet engine is practically an adaptation of the internal combustion engine to fit it for using superheated steam. Fig. 24 is a side view of the engine, half of it being shown in section. It has four cylinders and a two-throw crank, but only two cylinders A A are shown, as the other two are immediately behind them. It is a single-acting engine, that is to say, each piston is forced towards the crank by the steam, but it is not forced back. Instead of slide valves, mushroom valves (see chapter on Petrol Engines) are used. H shows one of these valves in section, the steam inlet valve. The exhaust valve to each cylinder is exactly the same as H, but as it is behind it cannot be shown in the drawing. The exhaust steam passes through J and out at J^1. The valve H is kept closed by a spiral spring, which encircles its stem, and H is opened and closed by the to-and-fro motion of F through G, F being moved by the cam E on the cam-shaft D, which is driven by a toothed wheel on the cam-shaft C, working into a similar toothed wheel on crank-shaft D. The exhaust valve is similarly operated, and the engine is reversed by sliding another pair of cams under the rollers working the valves. A piston B

drives the crank direct through the connecting rod K, exactly the same as in a petrol engine. L is the flywheel, and M a tap for letting dirty lubricating oil out of the crank chamber. Each of the four cylinders works in a precisely similar way to the one described. In some engines the valves are parallel with the cylinders instead of slightly inclined as shown in fig. 24.

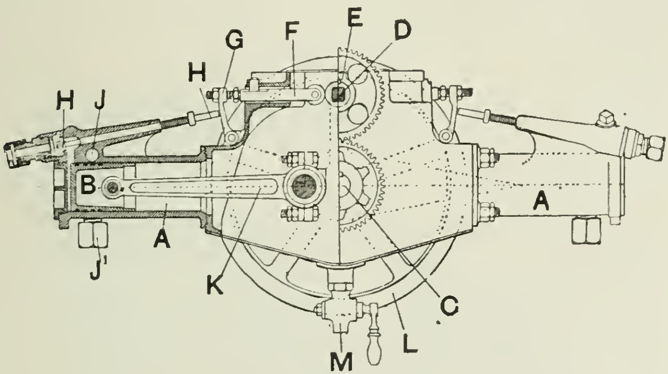


Fig. 24

Part sectional elevation of the Serpollet Engine

The Turner-Miesse engine is identical in principle with the Serpollet with the difference that, in place of having four cylinders in opposite pairs, only three are used, and are set in line acting upon a three-throw crank-shaft, the cranks being set at 120°.

Condensers.—In damp weather, when using a full supply of steam, the exhaust from the engine shows, just as on the same sort of day the steam from horses becomes visible; and to obviate this condensers are used. Upon many steam cars the Clarkson condenser is in use. This is described as a 'radiator' in the chapter dealing with internal combustion engines, and needs no further description here, except to say that, instead of water being passed through it, the exhaust steam from the

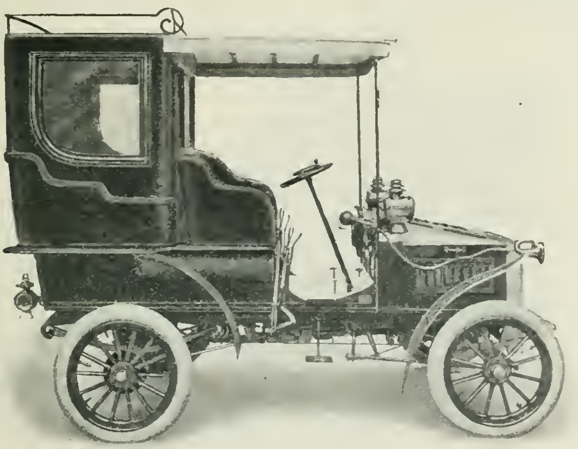
engine takes its place and issues from the bottom of the condenser almost invisibly in a small stream of hot water. In the Serpollet, Miesse, and other cars different forms of condensers are used, but the action is the same. They consist of long ranges of pipes exposed to the air, through which the steam is passed and so condensed into water. Some of the best steam cars are fitted not only with an efficient condenser, but also with an oil separator and a water filter, as the steam, instead of being dropped on the road after condensation into water, is pumped back into the tank and used over again. By this means a car can be driven at least double as far without renewing water, that is to say, from sixty to one hundred miles or more.

The Car.—We do not deal here with the car itself, nor with the transmission, as the latter has a special chapter reserved to it, and the cars, beyond their simpler transmission, are similar to the petrol carriages. It should be understood that the makes we have mentioned are cited as examples. No attempt has been made to mention numerous interesting types which do not differ in their main essentials from the cars we have described. The novice who first examines a steam car may possibly be somewhat appalled at its apparent complication, but if he examines the pipes and connections generally, and ascertains their exact mission, he will soon see that the apparently bewildering multiplicity of parts is not very formidable after all. There is no mystery whatever about the mechanism; it merely needs a short study to be easily appreciated.

As compared with a petrol car, the main advantages of a steam vehicle may be summarised in its quietness and evenness of running, ease of starting and restarting, and the great range in the power of the engine, which stops and starts with the car, and can also when necessary be used as a very powerful brake. Steam cars do not put such hard work on the tyres as those driven by petrol, as the engine power is softer in action. The transmission of the power from the engine to the road wheels

is much simpler than it is in the case of the petrol car, but the boiler, burner, &c. make up for this simplicity.

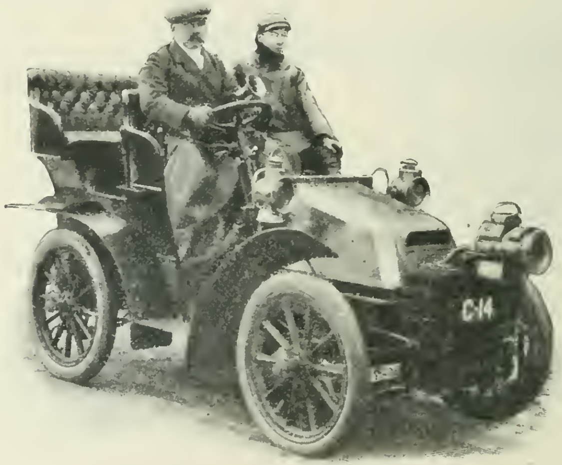
The Art of Driving.—Almost anyone can drive a steam car in a few minutes, but it requires experience to get the best results. The great art of driving is always to have sufficient steam in hand to get up any hills that may be met with on the road, and at the same time to keep down the consumption of fuel and water to the lowest possible limits. Considerable space might be devoted to discussing the niceties of the art of driving a steam carriage,



A White Steam Car, with Limousine Body

but they may be summarised as consisting in the maintenance of an even steam pressure and mean water level on all conditions of roads, with a minimum consumption of fuel and water. If the owner take the trouble thoroughly to understand his car and its mechanism first, and then bears this rule in mind, he will soon acquire the art, and will learn to take advantage of every variation in the gradient and road surface. Linking up plays a very important part in the economy of fuel, and by doing this whenever circumstances permit, by cutting down the fire when descending hills, and by using steam with modera-

tion at the foot of a long hill, it is wonderful what can be done. It is also necessary to remember that the best results will be obtained by keeping the boiler fairly full. If the water be allowed to get low, a large supply has to be given to it at one time, and this results in an instant drop of steam pressure. Care should also be taken that the engine and all working parts are properly oiled—never allowed to run dry or to be flooded with needless oil. The boiler should be 'blown down' twice a week when the car is in use. When the drive is



A Turner-Miesse Steam Car

finished the pressure should be allowed to fall to 50 pounds, and then the blow-off cock or tap opened so that all the water is blown out, and with it all sediment and deposit which would otherwise form a coating on the inner surface of the boiler and tubes. This is like the 'fur' in a kettle, and not only reduces the steaming power of the boiler, but also eats away the metal. So long as the boiler is regularly 'blown down' it will not get furred.

Quite apart from questions of economy, the owner who

studies his car and endeavours to get the best results out of it will find that his interest in the pastime is greatly increased, as he is provided with an interesting occupation the whole time he is driving, and never for one minute does the way seem long or the driver feel bored. Finally, the driver should always make a point of seeing that everything is in good order, as it should be before he starts out, and he should not leave trifling but necessary adjustments, which might have been seen to before he started, to be performed on the roadside. If he follow this advice he will have a vehicle which is as trustworthy as a railway locomotive, and almost as durable.

CHAPTER XIII

ELECTRIC CARS

By the Editor of 'The Automotor Journal'

An electromobile is a vehicle propelled by one or more electric motors driven by current supplied by accumulators carried on the car itself.

In dealing with the subject it is not proposed to go into detail as regards matters of car-construction, arrangements of gearing, or the other features which every electromobile necessarily possesses in common with other self-propelled vehicles; the intention is to deal mainly with the special features which characterise it, the assumption being made that readers are now familiar with the general mechanical principles involved in all classes of self-propelled vehicles.

An electric vehicle may be regarded as consisting of a body, a running gear, with one or two motors mounted on it and arranged to operate the driving wheels of the vehicle through speed reduction gearing, of a battery of accumulators carried on the car itself, of connections between this battery and the motors, and of a controller, the functions of which will be explained.

It will perhaps be best to deal with the subject in accordance with this general division, and first of all to consider the principles and characteristics of electric motors and accumulators, after that the connection between the two—under which heading the construction of the controller will be discussed, and the general principles will be considered. Then it is proposed to give a cursory description of different types of running gear, illustrated by a couple of actually running electric

vehicles; finally to treat of the ailments and misfortunes to which electromobiles are subject, and the general prospects and position of electromobilism at the present day.

An electric motor is a machine which produces rotary movement owing to the magnetic action caused by an electric current.

Everyone is doubtless familiar with the ordinary magnet, a piece of steel either straight or, more often, shaped like a horseshoe, possessing the property of attracting certain metals which are termed magnetic, or more accurately para-magnetic. Nickel and iron are amongst those which are attracted, but iron is much more powerfully attracted than nickel.

Next to the faculty of attracting iron, the most characteristic property of the ordinary magnet is what is generally known as polarity. Its two opposite ends possess different properties. This is not apparent when a magnet is applied to soft iron, which is unmagnetised, but is obvious when one magnet is applied to another. The ends and poles of the magnets are usually distinguished by being called north and south poles, and designated by the letters N and S. By the north pole of a magnet is generally meant the end which, if the magnet be very freely pivoted or floated on water, will point towards the north. The south pole is the other end. Sticklers for accuracy call these different ends the northward-pointing pole and the southward-pointing pole. We will content ourselves with designating them simply by the letters N and S. If a bar magnet be broken in two, each broken portion also displays polarity. If two magnets be confronted, with the N pole of one opposite the S pole of the other, they will attract one another. If the two N poles or the two S poles be brought together, repulsion will result.

The main property of electricity, or, to be more correct, of an electric current, which is of most importance in connection with the production of movement by its means, is its power to produce magnetism.

We do not know precisely what electricity is, and by

implication we do not know precisely what an electric current is; but we have all requisite knowledge about it for practical purposes. An electric current is a something which occurs in a conductor, i.e. a piece of metal when it connects two points between which there is electric pressure. The current may be only momentary, as in the case of Franklin's kite with a wire attached which was sent up into a thundercloud, or when a so-called Leyden jar is discharged; or it may last longer, as when we discharge a dry cell. Finally it may last some hours, as in the discharge of an accumulator; but while it lasts its characteristics—the effects it produces—are the same. It heats the metal through which it flows, and it produces magnetism in the neighbourhood. The difference of electric pressure between two points is termed potential difference, and it is measured in 'volts.'

Every conductor opposes a certain amount of resistance to the passage of the electric current. This resistance is measured in what are called 'ohms,' the ohm being a unit of electrical resistance. It is the electrical resistance of a rod of copper of a certain length and thickness when at a certain temperature. The electric pressure or difference of potential which will send a certain amount of current, called an 'ampere,' through a conductor the resistance of which is an ohm, is one volt. It is half the pressure approximately existing between the terminals of an ordinary accumulator, and is about enough to heat half an inch of thin platinum wire red-hot. Volts, amperes, and ohms are all mutually dependent units of measurement—thus, if along any wire, the resistance of which we know to be an ohm, there is flowing one ampere of current, we know that the electric pressure or voltage between the ends of that wire is one volt. If there be a difference of pressure at the ends of the conductor of one volt, and we find that there is half an ampere of current flowing, we know that the resistance is two ohms. If we have a pressure of two volts maintained between two points, and we connect those two points by a wire, and find that two amperes of current flow through

it, we know the resistance of the wire is one ohm. The analogy with the phenomena presented by liquids, such as water moving in pipes, is very close. Voltage corresponds to the pressure or head of water, ohmic resistance to the skin friction between the pipe and the running water, and amperage to the amount of water passing, say, in gallons per minute. Voltage, amperage, and ohmic resistance are measured in practice by special instruments called voltmeters, ammeters and ohmmeters.

The novice is sometimes troubled by having to familiarise himself with the notion that an electric current can flow through, or in, such a solid thing as a copper wire. Some people would perhaps find it easier to understand electric phenomena if conducting wires were made hollow. Persons who take this point of view may, however, console themselves with the reflection that a wire is not as solid as it looks, and also that some of the electric current runs along the outside.

An electric current produces a magnetic condition, generally called a magnetic field, in the neighbourhood of a conductor —say a wire—along which it is passing. If a wire be wound into a helix, as at W in fig. 1, and if an electric current be led into it through the flexible conductors or brushes B and B^1, it would act in a feeble way like a magnet. If the current be stronger, it will act like a stronger magnet, and it will have one pole near where the current comes in and another pole where the current goes out. If a rod or core of soft iron C be slipped inside the coil of wire W, and insulated or electrically separated from it, so as to prevent the electric current from passing through it instead of through the wire, the core C will become a powerful magnet. As long as the electric current is passing it forms an *electro-magnet.* When the current ceases to flow, the iron will lose its magnetism—that is, provided it is soft. If a core of hard steel be used, it will take some time to become magnetized, but when it is magnetized it will be a permanent magnet. It is in this manner that soft iron and steel differ magnetically. If N, in fig. 1, be the north pole of a magnet

(whether the pole of a permanent magnet or of an electro-magnet does not matter) and if the current passes along the wire W so as to produce a south pole near the top of C slightly below N, and if the coil and core be capable of upward movement only, there will be a tendency for W and C to rise.

If a casting of soft iron or mild steel, shaped like M in fig. 2, have an insulated wire W wound round it in the manner shown, and a current passed round it in the direction of the

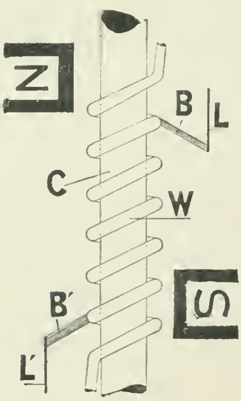


Fig. 1

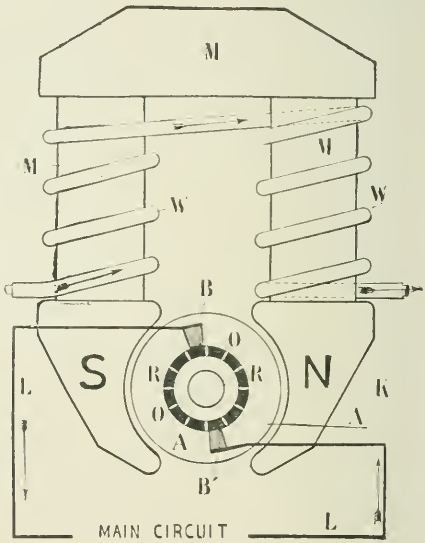


Fig. 2

arrow, an electro-magnet will be produced with powerful poles, capable of strong attraction as at N and S. It will be understood that the windings are of course merely diagrammatic, many more turns of wire being used in actual practice.

If a soft iron ring, C, fig. 3, have a wire W continuously wound round it, and the current is supplied to this wire through the flexible brushes B, B^1, from leads L and L^1 coming from a battery of accumulators, the ring will become magnetic, and will resemble

two half ring magnets put together, there will be a double pole of one kind where the current enters, and another double pole of the opposite kind where the current goes out. If the brushes be arranged to slip from one coil of the wire W to another, then if the whole wire-wound ring C be turned round, the magnetic poles will remain constant in space, although the ring turns round. If such a ring be mounted between the poles of such an electromagnet M, as shown in fig. 2, there will be a permanent pull on one of its pairs of poles in one direction and a permanent pull

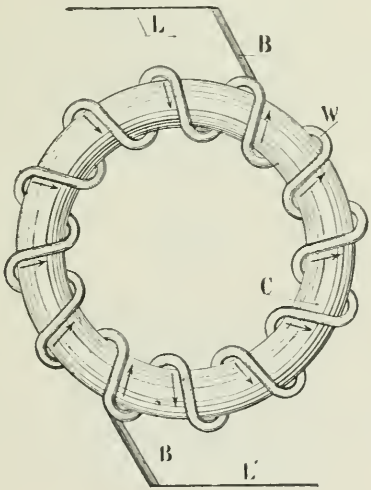


Fig. 3

on the other pair of poles in the opposite direction. Now the position of these poles in space is permanent, and depends upon the position, as already explained, of the brushes B and B^1. The result is that perpetual rotary pull or *torque* is produced in the ring and it turns round. The amount of torque produced is dependent upon the amount of magnetism present, that is upon the strength of the poles N and S, and the strength of the poles produced in the ring C; and this depends on the strength of the current flowing, and the

number of turns of insulated wire. It will be understood that if the magnet M, fig. 2, were a permanent magnet instead of an electro-magnet, movement would still occur, but an electro-magnet can be made so much more powerful than a permanent magnet that electro-magnets are invariably used in ordinary practice.

The ring shown in fig. 3 represents a Gramme ring, which was one of the earliest and simplest forms of *armature*, i.e. revolving portion, employed in electric motors. In practice the current is not brought to it as shown in fig. 3, but a device called a commutator, shown at K, fig. 2, is employed. The ring is mounted on a spider and a shaft which revolve in suitable bearings. The commutator K consists of a ring of conducting segments R R, separated by insulating pieces O O. Each one of the conducting segments R R is joined up by a wire or rod to equidistant portions of the armature winding W, so that the current supplied to the commutator by the brushes B, B^1 enters the winding W, in the same manner as shown in fig. 3.

Fig. 2 shows a simple form of electric motor, of what is called the 'separately excited' type—that is to say, the electro-magnet is rendered magnetic or excited by an electric current proceeding from some separate source of electricity, such as a battery separate from that which supplies the electric current to the rotating part or armature. Fig. 3 represents, as already stated above, the Gramme ring. This is a form of armature which is but little used in electric motors, some form of drum armature being now almost universally adopted. The drum armature is a development of the Siemens shuttle armature, and will be best understood from the inspection of a section of that arrangement, fig. 4. In this section X is the spindle of the armature, C being the iron core, shown in the rounded H section, and W the coil of wire covered with insulating material I. The whole arrangement is very much longer than it is thick, and really does resemble a shuttle. The two poles are formed by the sides of H. Instead

of arranging all the wire in a single winding, we may distribute it over the surface of a soft iron cylinder, connecting it up to the sections of the commutator. This forms a drum armature, and is used in the great majority of electric motors employed on electromobiles. Such drum armatures of course differ in proportions, but the general arrangement is the same.

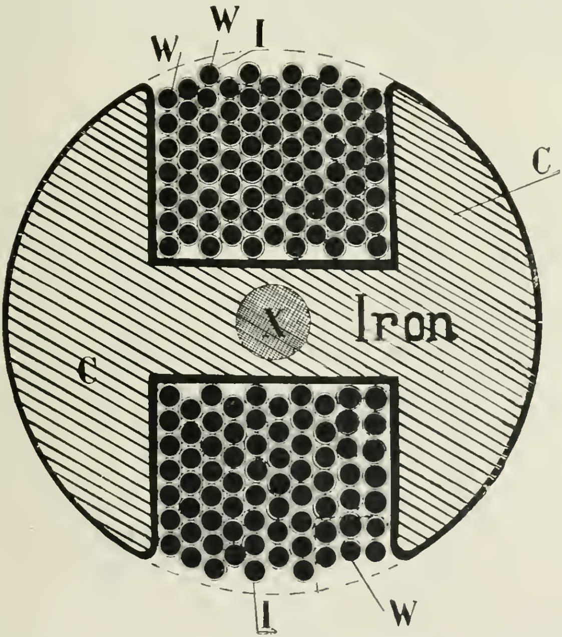


Fig. 4

Figs. 2, 5, and 6 illustrate the three main types of the two-pole electric motors. Fig. 2 shows, as already explained, a two-pole separately excited motor. This may be looked upon as a motor in which the magnet is rendered magnetic by a current from a separate battery (a few accumulator cells usually sufficing for this purpose). To all intents and purposes it may be regarded as if the separately excited

magnet were a permanent hard steel magnet of the same shape.

The two other types of motor are the shunt-wound motor, fig. 5, and the series-wound motor, fig. 6. In the shunt-wound motor the current, which is led by two conductors from opposite ends of the battery of accumulators to the brushes which supply the current to the commutator, and so to the armature, branches off from those brushes and goes round the

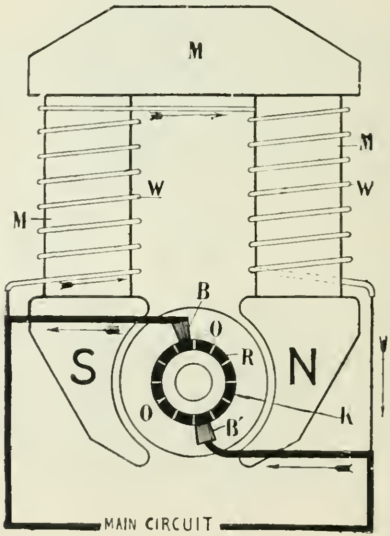


Fig. 5.

coils wound on the field magnet. In the series motor the current traverses the field winding either before or after passing through the armature. There is a fourth variety of motor, known as the compound, in which the field magnet has both series and shunt windings. This type of motor is used on some electromobiles.

The characteristics of series and shunt motors are different. The shunt motor tends to run at constant speed, no matter

what the load may be, provided the voltage or pressure of the current supplied to it be the same ; and it will consequently try its best to force a car provided with it through mud or uphill at the same pace as it would drive on the flat. The series motor, on the other hand, more or less apportions its speed to the load, and will go slower uphill and faster on the flat. The series motor has this additional advantage compared with the shunt motor, that it produces a greater starting torque or turn-

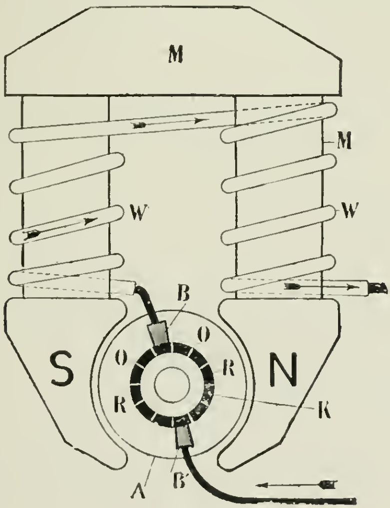


Fig. 6

ing moment—that is to say, series motors are better calculated than shunt motors for starting a car from a state of rest or getting it out of difficulties. Generally speaking, we may say that, for automobile purposes, series motors and separately excited motors, which present some of the characteristics of a series motor, are to be preferred for the propulsion of vehicles.

The motors employed in electromobiles, although constructed on the same general principles as the diagrammatic dynamos we have just described, vary considerably both in

detail and in shape from one another. Many of them have four poles, and the brushes which lead the current to the commutator are usually of carbon, held in special brush-holders suitably pivoted. It might be supposed that, having four poles, four brushes should have been provided, and some of the original four-pole motors were so constructed. It was shown, however, by Mr. Mordey that by connecting the opposite wires on an armature in parallel with one another two brushes only might be employed instead of four. Electrically this is of course the same thing as using four brushes and cross-connecting them.

Other types of motor have also been employed successfully for the propulsion of electromobiles. Noticeable amongst these is the Joel, in which the armature, constructed on the drum principle, is arranged outside an eight-pole field, round which it revolves.

The modern electric motor is the most efficient machine in existence. Motors can be constructed which convert upwards of ninety per cent of the electric energy supplied to them into mechanical energy. The efficiency declines as the size of the motor diminishes, but motors of an eighty per cent. efficiency are practicable for automobile purposes.

The electric motor is also exceedingly compact and is usually *ironclad*—that is to say, it is rendered impervious to dust, dirt and water by being completely self-contained. As regards the amount of space it occupies, it compares favourably with any other form giving the same amount of power. As regards weight it is heavier than the petrol motor.

Its leading feature, however, is its magnificent flexibility. It will start from a position of rest and run up gradually to the required speed without jolt or jar, and as varying speeds can be obtained by grouping parts in the motors and the batteries, no change-speed gears are required in an electric car, a single speed reducing transmission gear being all that is needed.

Above all, the electric motor is practically noiseless, and it emits neither visible vapour nor effluvium.

Assuming a vehicle with running gear complete and motors mounted and geared to the driving-wheels, the motors have to be fed with energy in order that the car may be propelled—that is to say, we must in addition to the motors have a source of electric current present. A car with body, running gear, and motors geared in position, is a potentiality only. It requires an electric current to vivify it and enable it to move.

Attempts have been made to propel electric vehicles with primary batteries. They have neither been successful technically nor commercially. At the present day the secondary battery or accumulator is the only adequate source of electric current for the propulsion of motor vehicles which is self-contained and trustworthy. It is just conceivable that a car might be propelled by some such battery as the Cupron, but the attempt could hardly have commercial success.

An accumulator may be looked upon as a reversible primary battery.

It has already been assumed that everybody is familiar with the common or horseshoe magnet. It will also be assumed that everybody is acquainted with the ordinary galvanic battery, but it may not be amiss to recapitulate its leading features.

If a plate of pure zinc and a plate of pure carbon be immersed in dilute sulphuric acid and connected outside the vessel in which they are placed by a metal wire, an electric current will flow along the wire from the point at which it is connected with the carbon to the point at which it touches the zinc. The current, however, will not flow for long. Soon after the wire connection between the two plates has been made, it will be observed that the surface of the carbon plate becomes covered with a layer of bubbles of gas, which increase in quantity till the whole plate is covered and the bubbles disengage and rise to the surface. The bubbles are hydrogen gas (due to the decomposition of the acidulated water by the zinc), and their formation on the carbon plate stops the further production of the electric current. This is known as polarisation. In the ordinary Bunsen battery, the carbon

plate is set up inside a porous vessel containing nitric acid—a powerful oxidising material—the zinc remaining immersed in dilute sulphuric acid. The nitric acid oxidises or burns up the disengaged hydrogen, and by so doing produces additional electric energy; and therefore the voltage of a Bunsen cell is higher than that of a plain zinc carbon combination. If we could keep all the contents of the porous pot from escaping outside it, we could restore a Bunsen battery to its original condition by passing an electric current in the opposite way to that originally produced. This would reproduce the nitric acid which had reacted with the hydrogen and redeposit on the zinc plate the zinc that had been dissolved by the sulphuric acid, in the same way as a metallic deposit is produced by electroplating. In this manner the battery would be restored to its original condition. This cannot be done in practice because the nitric acid escapes from the porous pot and attacks the zinc directly.

One element of a secondary battery, or accumulator, consists of a so-called positive plate and a so-called negative plate immersed in dilute sulphuric acid. The positive plate consists of a leaden framework or grid filled up with electrically produced peroxide of lead. The negative plate consists of a corresponding leaden framework filled up with porous or spongy lead, also produced electrically. The positive plate corresponds to the carbon plus the nitric acid, the negative plate corresponds to the zinc in the primary battery. When the positive plate is connected by a conductor—say through a motor—to the negative plate, an electric current passes from the one to the other, and the battery discharges. Instead, however, of the negative plate dissolving as in the case of a primary battery, the spongy lead becomes converted into sulphate without dissolving. The hydrogen gas which would appear at the surface of the positive plate is oxidised by the lead peroxide and reduces it. The electric pressure registered by a voltmeter arranged in the external circuit and connected to the positive and negative plates is a little over two volts when

the accumulator is freshly charged. When the accumulator has given a certain amount of current for a certain length of time, a large proportion of the spongy lead on the negative plate is found to be covered with sulphate of lead, and a large proportion of the lead peroxide on the positive plate is then reduced. The electric pressure which the cell furnishes becomes diminished, and the accumulator is said to be discharged. The accumulator should under no circumstances be discharged after a voltmeter connected from plate to plate shows that the voltage has sunk to 1·75 volt per cell.

When a primary battery is discharged it cannot be used again except by renewing the materials, but an accumulator when it is discharged, by having furnished current for a certain prolonged period, can be charged—that is to say, restored to its original condition—by forcing the current through it the wrong way, that is in the opposite direction to that in which the current flows when the accumulator is being discharged. It is this feature of the accumulator which renders it a practical appliance. When it has given out an electric current for a certain time, it is merely necessary to connect it to the terminals of a suitable source of current at the required pressure to recharge it. It is generally advisable to charge an accumulator at about the same rate—that is to say, at about the same number of amperes—that it normally discharges at, but this is not absolutely essential, as the charging rate may exceed that very considerably, and with a good type of cell it is practically only limited by the heating produced. The pressure or voltage required to charge a battery is somewhat higher than that which it gives out, and is generally about 2·5 to 2·6 volts per cell.

There are two types of ordinary, lead, accumulator batteries, those in which both positive and negative plates are 'pasted,' and those in which the positive plates are originally composed entirely of metallic lead, cast so as to expose a large surface to the action of the dilute sulphuric acid, a coating of peroxide of lead being formed upon it by the action of the electric current.

Amongst recent inventions connected with accumulators,

the Edison battery is of chief importance, and although it is as yet impossible to assign a true relative commercial value to it, yet the very severe trials to which it has been subjected have already proved it to be a powerful rival to any lead-lead cell now in use. One of these batteries has successfully run a carriage a total distance of over 2,000 miles, and the various laboratory tests conducted by several independent experts with sample cells have given some very remarkable results. In this battery the positive plates are made of nickel, the negative plates of iron, and the liquid in which they are immersed is caustic alkali. The *grids*—i.e. the frameworks—for all the plates are made of steel, are nickel plated by a special process to render them impervious to the action of the caustic alkali; the containing boxes are also constructed of the same material, and are treated in a similar manner. The *active material* for both positive and negative plates is pressed hydraulically into hard regular blocks before being inserted in the grids, that for the positives being a mixture of nickel peroxide and flaky graphite, and that for the negatives being spongy iron mixed with flaky graphite. The voltage of each cell is but little more than half that of an ordinary accumulator, though in spite of this, the weight of a complete battery, capable of storing an equivalent amount of electrical energy, is practically the same. So far as is now known, the Edison battery is somewhat more bulky than the best lead-lead battery, but it is more durable, is of greater mechanical strength, and will stand considerably higher rates of charge and discharge without injury.

The type of automobile battery now chiefly employed is of lead-lead type, having both negatives and positives 'pasted.' The process of manufacture of such a cell will be best comprehended by reference to a special example, but, it should be pointed out, a good deal of difference exists between the various makers' plates, and that we can only give a general indication of the processes of manufacture. Fig. 7 shows the type of plate employed in the construction of the batteries built by the Accumulator Industries, Ltd.

The first step in the process of manufacture of the plate depicted in fig. 7 consists of mounting a sheet of thin pure lead, perforated in the manner shown, in a heated mould, in which a raised edge undercut at the sides is cast on to it, together with the lug or connecting piece projecting from the top of the plate. The grid thus constructed is smeared level with a paste mainly composed of ground litharge moistened with dilute sulphuric acid. The paste contains other things also. After smearing, the plate is dried in a warm room until the paste is thoroughly dry and hard, and the plate is then mounted with several others in a forming vessel of dilute sulphuric acid, in which it is connected to the negative pole of a battery of accumulators or a dynamo. The action of the current finally reduces the litharge to the condition of porous metallic lead, and the plate is then a negative, suitable for being assembled with other plates to form a battery cell. The positives consist of somewhat thicker plates, similarly made as negatives in the manner described, and then connected to the positive of a forming battery or dynamo till all the porous lead is changed into lead peroxide, when the plate has become a positive. Each of the plates, whether positive or negative, is covered over as shown in fig. 7 by a grille of ebonite, which assists in maintaining the *active material* in position, and also serves to keep the plates apart. A number

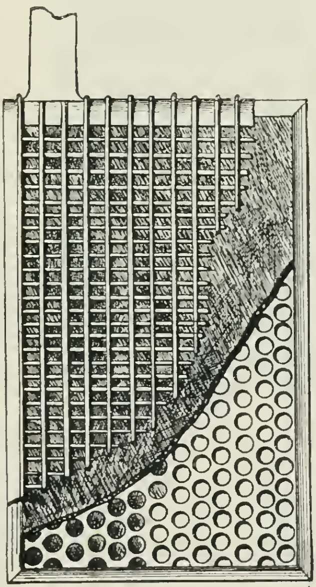


Fig. 7

of positive and negative plates, generally one more of the positive than of the negative, are assembled together in a cell as shown in fig. 8, additional vertical rods of ebonite being there shown in position to give wider separation between the plates. It will be observed that in fig. 8 the plates repose upon two longitudinal prominences at the bottom of the cell, which are technically known as bridges. These serve to keep the plates off the bottom of the vessel, so that if any of the material falls out between them, it shall not bridge across between the plates, causing a conducting connection to be formed, and the plates thereby discharged when not in use and injured. Each of the connecting lugs of each of the positive plates, visible on the near top side of fig. 8, is autogenously soldered to a cross-connecting bar of lead, which is brought up vertically to form the positive terminal.

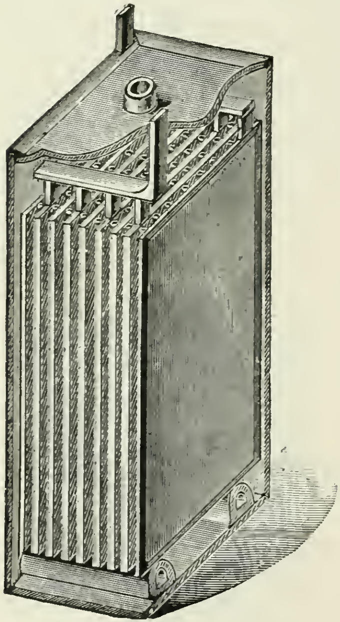


Fig. 8

The negative plates are similarly connected to another cross bar, this being brought up through the cover on the far side and forming the negative terminal. The process of soldering is carried out either by a hydrogen flame or by an electric welder. When the formed plates are mounted in position as shown in fig. 8, the cover, provided with a central hole for pouring in the acid and allowing the escape of any gases generated when the cell is charged, is put on.

The containing vessel of automobile cells is almost in-

variably of ebonite, which has proved itself to be a light acid-resisting material, and the most suitable for the purpose. The general arrangement of the plates and cells is very similar in all automobile batteries. The plates themselves, however, differ in the shape and construction of the grid, which sometimes resembles an open network, as in the Rosenthal and Oppermann batteries, and also in the composition of the paste and the methods of formation adopted. Some, too, are handmade, whilst others are to a great extent made by machinery.

As it will be recollected that each such cell, as shown in fig. 8, gives only a voltage of approximately 2·0, and as it is found that, owing to various reasons, the most satisfactory design of motors for electromobile purposes involves their being supplied with current at between fifty and one hundred volts—preferably nearer one hundred volts than fifty—a number of accumulator cells have to be arranged in series : that is to say, the positive terminal of one connected to the negative terminal of the next, fifty cells thus connected giving approximately one hundred volts. Of course, the motors will take more or less current according to their power, which is measured, as already explained, in amperes, and the size of the cells supplied to a car is consequently so arranged that the normal rate of discharge of the battery—that is, the amount of current measured in amperes it can give without inconvenience to itself—shall be the same as the amount of amperes required by the motor or motors to develop their normal power.

It must be remembered that an accumulator or battery of accumulators can be so utilised that twice or three times the amount of current that it was designed to give may be taken out of it. This will not do much harm if it happen only rarely, and for short periods, but if it happen for long and often, it will shorten the accumulator's life. To get good results, an accumulator should be treated with every possible care and consideration. An electric motor will also stand considerable overloading, but it is not so patient

as the accumulator, for under most circumstances of at any rate prolonged overload the motor will burn up before the accumulator is seriously injured—of course assuming that this accumulator has been properly designed for the work that it has to do.

For use in a car, accumulators are usually mounted, about half a dozen together, in what are termed nesting-boxes—that is, wooden cases a little shallower than the cells themselves. Such a bunch of accumulators forms a unit which can be separately handled for removal or insertion in the vehicle. The connections between the cells composing it should be flexible and should be easily removable when required. Some constructors mount the whole of the cells in one nesting-box or tray, so that they can be inserted by mechanical means, when charged, into a vehicle ; instead of the vehicle being kept waiting for the process of charging, the discharged battery box can be withdrawn and a fresh one inserted.

Let us consider the running gear of a car having two motors mounted on the rear axle and adapted to drive, by means of spur gearing, each of the rear wheels of the vehicle independently. We will suppose that we have a battery of accumulators mounted on the framework above described, consisting, say, of forty cells, arranged in two groups of twenty cells each, one at the front part of the frame, and one at the rear. We have to consider the problem of connecting the batteries with the motors. This would be a simple business if the car were designed to run on the flat at an always uniform speed, and if the surface on which it would be its fate to run could always be satisfactory, such as an asphalted street, for example. It would then suffice to connect the two terminals of one of the batteries to the two brushes of one of the motors and the two terminals of the other battery to the two brushes of the other motor, by means of cables covered with insulating material, switches for making and interrupting the connection being arranged in between. Such a car, however, would only have one speed, and it would take an

enormous current at starting, which would be very liable to burn up the motors and injure the accumulators. In order to give different speeds and to enable the amount of current taken by the motors at starting to be reduced, arrangements must be made for connecting either the motors or the parts of the motors, or the two halves of the battery, or both in different groupings. It must be pointed out that more current can flow through an electric motor at starting than when running, owing to the fact that when running it produces a kind of back electric pressure.

If, then, we used on each of the motors at starting the full electric pressure our battery is capable of supplying, a great deal too much current would be forced through the motors and they would probably be burnt up. We may reduce the effective pressure applied to the motors by putting the two halves of the battery in parallel, when we should be working with a pressure of forty volts instead of eighty. We may also work further in the same direction by putting the motors in series, thereby doubling—really quadrupling—their effective resistance. To enable this to be done we want, however, to take several connections from the motors and several connections from the battery, and connect them by cables to a number of different points between which the required electrical connections can be established by means of an appliance termed a controller. This usually involves some such arrangement as is depicted in fig. 9, which shows the controller used in the Joel car. It consists of a non-conducting cylinder along which strips of metal are arranged, the cables from the different terminals of the battery and the motors being brought up to the flat springs which are shown pressing against the cylinder. Turning the cylinder round to different positions, by means of the lever connected with it on the right, produces electrical junction of such a kind as to group the motors and batteries in various ways according to the requirements for starting, for producing different speeds forward and for reversing in accordance with the principles above described.

A multiplicity of arrangements may be and indeed have been adopted in electric cars, involving corresponding differences of structure in the running gear and the controlling arrangements. To begin with, a car may have one motor, which may

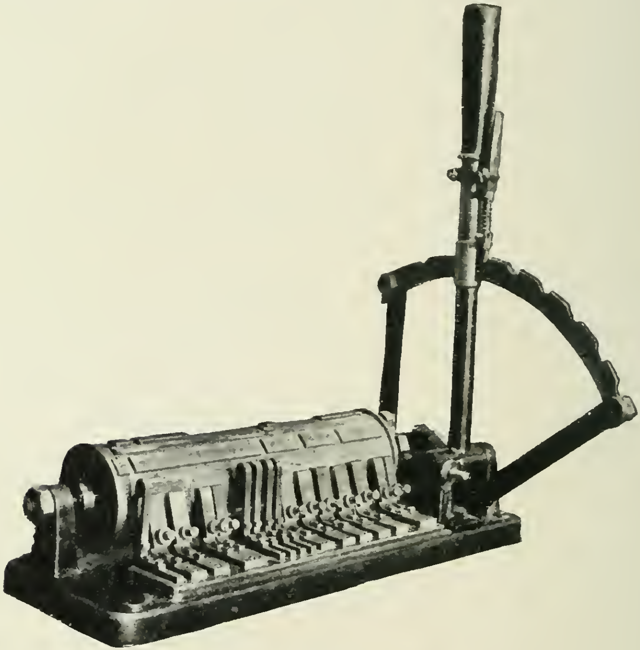


Fig. 9

be arranged in conjunction with a differential gear to drive the rear wheels by chains or gearing from the ends of the motor-shaft, the driving wheels running on a fixed axle. Or the driving wheels may be mounted on a live rear axle, the motor driving on to the compensating gear, either by a chain, by spur gearing, or by means of worm gearing, which gives a nice silent drive, and is used in the Oppermann cars. In any case the use of a single motor involves, in addition to the motor, a differential gear.

The advantages of a single motor are that it can be built with a somewhat higher efficiency than can be obtained with two separate motors, each of half the power, and that the cost of construction is less. There now appears to be a tendency towards the adoption of the one motor, and to employ it in conjunction with a live-axle. This is done by the Electromobile Company, on whose vehicles the power is transmitted from the motor to the differential (on the axle) by double-reduction, double-helical spur gearing; the armature of the motor, too, has two separate windings and two independent commutators, so that many of the advantages gained by the use of two motors are secured.

Cars employing two motors may have them mounted either to drive the front wheels, in which case the motors are necessarily mounted so as to turn with the wheels, or the motors may be mounted one to drive each of the rear wheels either by spur gearing or by chains.

The Krièger cars are conspicuous examples of the former class, and are in fact the only electromobiles in this country in which this method of driving has been utilised. The disadvantages are that there is a tendency for the wheels to slip when the car is going uphill on greasy roads.

The latter class with two motors comprises an immense number of successful vehicles, amongst which are those of the City and Suburban Electric Vehicle Co., Ltd. The advantages of two motors are numerous. If anything happen to one of the motors at a distance from home, it is almost always possible at a sacrifice of speed to get home with one. In the second place, a greater variety of speeds can be obtained; and thirdly, no mechanical compensating gears are necessary, the motors themselves giving the necessary differential action.

As regards the class of motor employed, the majority of electromobiles are propelled by series motors, a smaller number by compound motors, some by separately excited motors, and a few by shunt motors.

According as one motor or two are employed, the group-

ings which the controller is arranged and designed to effect will of necessity vary also. Where a single motor is employed, unless it be compounded and used in some such way as in the Krièger system, or be constructed like those of the Electromobile Co., differences of speed must be entirely provided for by grouping the battery cells in different combinations. Thus a position of the controller will be selected which puts all the cells in series on to the motor. Running on the flat this will give the highest speed. The next lower speed will naturally be obtained by putting the cells in two bunches in parallel with one another; that is to say, the positive terminals of each half battery will be connected together to one brush of the motor, and the negative terminals connected together to the other. This will provide half the pressure of the whole battery, and as the speed of the motor at the same load is dependent on the pressure at which the current is supplied to it, the car will travel more slowly. Lower speeds are produced by similar groupings giving lower pressure. Where two motors are employed a smaller number of groupings of the cells may be adopted, or double the number of speeds obtained with the same number of cell groupings, as with each cell grouping the motors may be arranged either in series or parallel with one another. In this case the maximum speed will of course be with the cells in series and the motors in parallel, the lowest speed with the motors in series and the cells grouped so as to give the lowest pressure. Generally one of the lower speeds—that is, with the cells arranged to give the lowest pressure—will be used for starting, because the motor, owing to its taking a large current before its speed increases, should not be supplied with current at a high pressure. As the batteries also, when arranged in parallel groups, are able to yield a heavier current, the arrangement is mutually advantageous for both batteries and motors. For reversing, the controller is brought into such a position as to send the current the reverse way through the armature of the motor.

An electric car does not require change-speed gear because

it practically constitutes a gear in itself. It accommodates itself to the load and does its best at any given load, or by varying the electric pressure it may be caused to increase or diminish its power within limits. Thus a series or separately excited motor can develop proportionately more torque in overcoming an increased load than it was developing before the load was enlarged. This effect may be increased by arranging the field magnets with a large amount of iron in their cores, and working under ordinary circumstances with a small magnetic density. On heavy loads, as when going uphill, the increased magnetic intensity produced by the increased current passing through the windings of the field magnets increases the torque, and at the same time tends to check the actual speed of the motor, thereby giving what may be looked upon as an electric gearing effect.

Another point of interest is that most motors when being driven become dynamos, and are capable of charging accumulators. Thus a suitable motor, when the car is running downhill, will give back current to the cells—will in fact 'recuperate' them. Not merely is some of the energy which would otherwise be lost in friction, by putting on the brakes, caught and put back into the cells, but the conditions of running are more favourable to the battery, when occasional short charges are put into it in this way.

It is advisable that every electric car should be provided with a voltmeter and ammeter in view of the driver's seat, so that he may know the condition of his cells and the amount of current he is taking out of them.

Figs. 10 and 11 show the 'chassis' of a typical modern electric vehicle, built in England by the Electromobile Co. It has a straight, rectangular, channel-steel frame, upon which the carriage body is fixed. The frame is carried upon the axles by semi-elliptic springs at each side, which together with the pneumatic tyres (810 mm. × 90 mm.) absorb all vibration set up by the road. The battery occupies the central portion of the frame and is contained in one large underslung box,

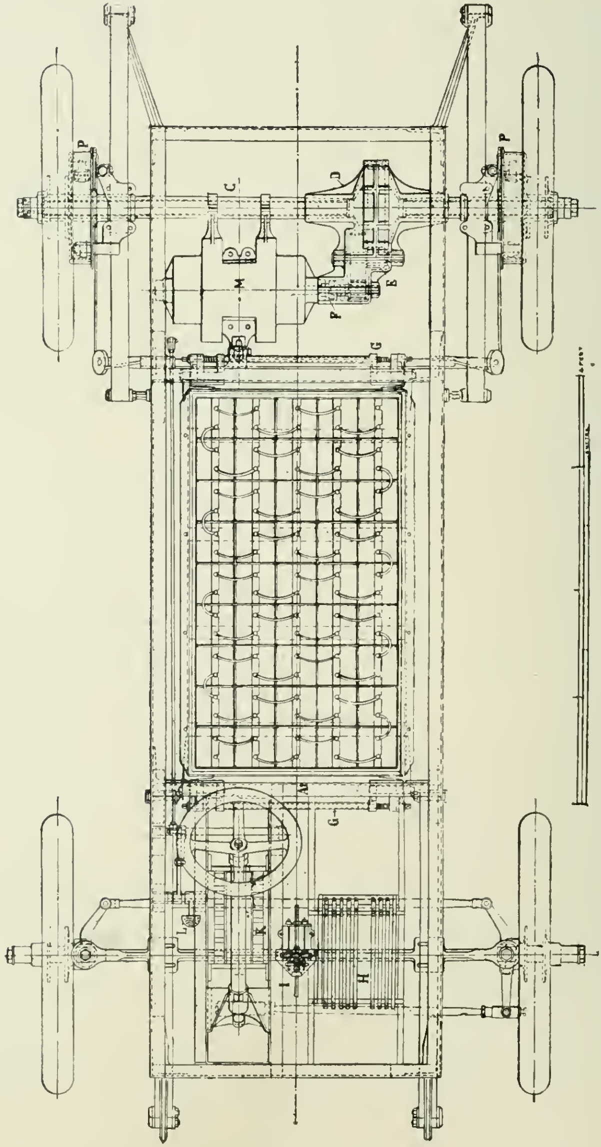


Fig. 10.—Plan of the Electromobile Co.'s chassis, showing the positions of the various parts of the mechanism

which is fixed by easily removed pins at each of its four corners. The box with its battery can be quickly attached to, or taken away from, any cars of this make, with the assistance of an hydraulic lift, so that a fully charged battery can be substituted for a discharged one in a few minutes. Forty-four accumulator cells constitute the battery, the plates of which are of the 'pasted' type, and their capacity of 135 ampere hours is sufficient for running the carriage a distance of from thirty to forty miles without recharging. The 'chassis,' together with the battery box, weighs $9\frac{1}{2}$ cwt., and the weight of the cells is about 10 cwt. The 2-pole series-wound motor, which has two distinct armature-windings and two commutators, lies immediately behind the back axle, riding upon it and being supported in front by a flexible attachment to the frame. It is intended to give 8 h.-p. at a speed of 1,500 revolutions per minute, but is capable of developing twice this power for short periods at a time. Double-reduction gearing, consisting of four double-helical spur wheels, is interposed between the shaft of the motor and the differential gear on the live axle itself, and these wheels—like the motor and the axle—are completely enclosed in dust-proof casings. The 'live' portions of the axles merely transmit the power to the two road-wheels, and do not take the weight of the vehicle, the bearings for the wheels being formed by the stationary tubular casing in which the shafts revolve. The controller is placed beneath the floor in front, and is connected with a hand-lever mounted about the sloping steering pillar. Speed between three and fifteen miles per hour, forward, can be obtained by moving the lever to the required extent over its indicating dial, and it has also three other positions, two of which give a 'brake' effect and the other a 'reverse.' A mechanical foot-brake, acting on the hubs of both driving wheels, is also fitted, and the pedal is so arranged that it first cuts off the current to the motor before it actually applies the brakes.

The construction of the City and Suburban Electric Carriage Co.'s vehicles differs from those of the Electromobile Co.

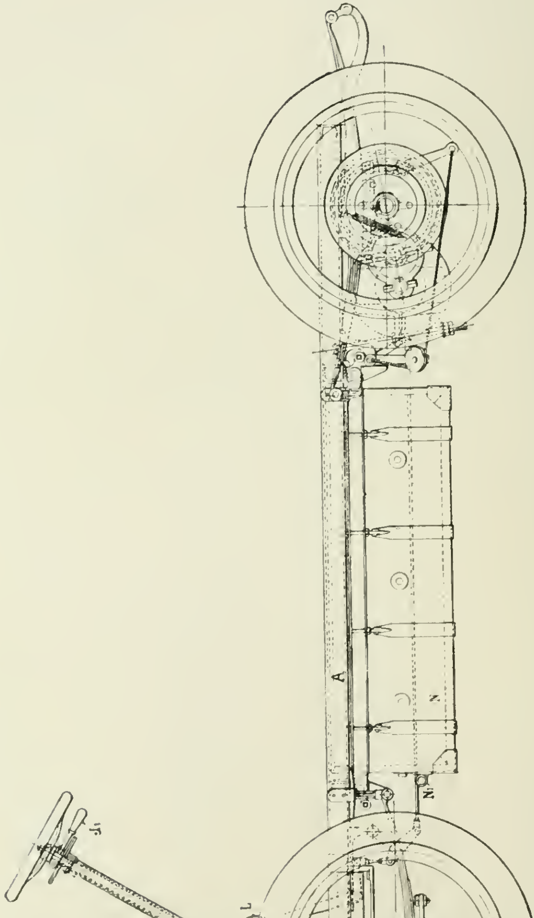


Fig. 11.—Side elevation of the Electromobile Co.'s chassis, showing the underslung battery-box

in several respects. Not only are the accumulators intended to be charged without removal from the car, and two independent motors employed, but 'reaches,' connecting the two axles together, are used instead of a chassis framework. In the standard cars, the accumulators (of which there are forty-four, having a capacity of 110 amp. hours) are mounted in one box, which is attached to the body either behind (in the ordinary Landaulet) or in front, beneath the driver's seat (in the 'Alexandra' model). Some special types are also built, having the battery, which weighs 11 cwt., divided into two boxes, the one fixed in front and the other behind. Each of the series-wound motors is capable of developing about 5 h.-p. for short periods, and is built to give 2·2 h.-p. continuously. They are fixed to the stationary axle behind which they lie, and are flexibly attached to the reach bars. The shaft of each motor carries a steel spur-pinion (with raw-hide centre) which meshes with an internally-toothed gear-wheel fixed to the hub of the wheel that it drives, so that the rear wheels are separately driven and there is no need for any differential gear. The majority of these cars have thirty-two inch tyres, and the motors run at seven times the speed of the road-wheels, but on some of them larger driving wheels (shod with thirty-six inch tyres) are fitted. Some of the vehicles have wheel-steering and others have a tiller, so that the position of the controller varies accordingly. In the former case it is fixed at the base of the steering pillar, and is operated by a lever lying below the wheel, whilst in the latter case it is placed beneath the driver's seat, with its lever projecting up through the centre of the seat. It gives three speeds both 'ahead' and 'astern,' representing about four, eight, and twelve miles per hour, but does not provide for any 'electric brakes.' Mechanical brakes are arranged on the shafts of both motors, and also on the hubs of the rear wheels, the former being simultaneously applied by a foot pedal, and the latter by a hand-lever at the side of the car; neither brake, when operated, interrupts the flow of current to the motors.

In accordance with the practice that has been observed in treating of other types of automobile vehicles, it is proposed to give a short description of the ills and misfortunes to which electromobiles are subject, together with some very cursory directions for detecting them and effecting their cure.

To begin with, however, it may be observed that an electromobile is, apart from the battery, much less liable to disarrangement of its functions than almost any other type of automobile. When the car is finished and provided with properly designed and geared electromotors, and furnished with an adequate battery and properly constructed controller and connections, it very rarely happens that anything gets out of order, and practically mishaps can only occur when a heavy electric vehicle is being forced up a steep hill either through heavy mud or at irrational speed. There is no doubt whatever that the trustworthiness of an electromobile is one of its most attractive characteristics.

If anything goes wrong with an electromobile it is well-nigh bound to be something happening either to :

The electric motors
The battery
The controller, or
The connections.

Of course, in addition to these things, gears may get out of order, or tyres may puncture ; but such misfortunes are common to all cars, and it is not proposed to treat of them here. As regards the gearing breaking or stripping, that is comparatively inexcusable in an electromobile, as the kind of effort which an electric motor exercises is a steady and continuous one, and the gearing is subjected to none of the jerks and jars which occur when an explosion engine is the motive power, and when change-speed gear is manipulated by an inexperienced hand.

The motors may fail from various causes. They may burn up, if too much current be forced through them in an attempt to get up a steep and muddy hill beyond the due limit of

speed. When the motor proposes to burn up there is no doubt at all about the fact. It begins usually some minutes previously to diffuse an agreeable perfume, not very dissimilar from the smell to incense, the result of the vaporisation of the shellac which is used in the insulation of the windings. It is quite possible for a motor to diffuse this perfume without actually burning up, this merely being an evidence that the motor is getting extremely hot ; but the wise man when he perceives it will usually, if possible, put his controller into a

Electromobile Co.'s Single Landaulet

Extreme length, 10 ft. 9 in.

position giving less current to his motors. Burning up nearly always means rewinding the part affected—an expensive performance. The burning up of an armature, however, is always much worse than the burning up of a field, as nearly everybody can wind a field, but an armature winder is a skilled mechanic, who commands high wages.

A motor may under circumstances refuse its work altogether, that is to say object to starting, though in a well-constructed car this is a very unusual occurrence. It may be due

practically to two causes: to the brushes not making contact on the commutator, which can easily be seen by pressing on the brushes with the hand, or to imperfect contact between the windings. The best way to ascertain whether this latter defect occurs is to get a dry cell and a galvanometer or voltmeter, and test the motor through from terminal to terminal and from section to section of the commutator.

Failure occurring in the batteries is practically never a sudden affair. It generally makes itself apparent by gradual diminution of capacity—that is to say, the batteries refuse to give their proper amount of current for the required time, and this state of things gradually gets worse and worse. Premature depreciation is nearly always due to the batteries being forced to give more current for prolonged periods than they should, and generally results from the dropping out of paste from the positive plates, or to an interference with the continuity of the paste and the conductor. In badly mounted batteries failure may be due to short circuiting, owing to some of the active material falling out on to the bottom of the cell, and bridging the plates across. In general, however, the failure of a well-constructed battery, within the period for which it ought to run, is due to overwork.

It is well at intervals to employ a cell-testing voltmeter to test all the different cells, as it may sometimes happen that one or two cells get into bad condition. If their voltage is low towards the end of a run the main battery will be charging them round the wrong way, and they will in consequence be injured. If the same cells persistently show low voltage, they ought to be removed and examined. Hence easily detachable connections are advisable.

The injury nearly always occurs to the *positive* plates. Consequently a battery that has been maltreated may practically be rendered as good as new by renewing the positive plates. As the connections, battery boxes, and negative plates are not influenced, renewal of the positive plates can generally be effected at a reasonable price.

All battery connections should be seen to frequently, and if any sign of oxide or verdigris appear should be promptly removed and cleaned. They should also be kept thoroughly tight. The owner of an electric vehicle should, if he suspect his batteries of being in an unsatisfactory condition, get them examined by the builder of the cells, as it requires much special experience to know whether a battery really requires renewal, whether the positive plates only should be renewed, or in fact how it should be treated.

Failure of connection between the controller-cylinder and the contact springs may also give rise to stoppage. That is very easily tested by putting the controller in the position in which the car refuses to move, and testing the contact springs by pressing them against the cylinder. If the car then starts they require tightening.

If the batteries and motors are all right in any particular position, and the car refuses to move even when the controller is tested in the above-described manner, there may be failure in the connections. Whether this is so or not can to a certain extent be judged by noticing whether the controller sparks when moved from one position to another. If it does so the current is passing and the connections are presumably all right; otherwise the connections are probably faulty. They can be conveniently tested with a dry cell and galvanometer, after having disconnected the wires from the accumulators. Heating at any point is usually the effect of a loose contact.

If the conducting cables are badly arranged, so as to rub on any metallic portion of the car, the insulation may be worn through and short circuiting ultimately result. It is therefore of the greatest importance to see that no such contact of the cables with any portion of the car ever occurs.

Similarly, accumulator connections should preferably only be made to the nesting-boxes and the connections with the cables made from contacts on these.

Electric vehicles can be charged in two ways, either by connecting the car directly to a suitable source of current, or

by employing two or more batteries, one of which is always kept charged at the charging station, the arrangement being that when the battery on the car is run down it is taken out and a freshly charged battery inserted. This latter arrangement is usually only practised in stations or 'garages' where a number of cars are kept. Charging on the car is a much more common proceeding. For this purpose the car should be provided with a plug and short length of cable, which should be carried with it. It is also advisable to have variable resistance. In charging the battery the cells are of course all arranged in series. Forty-four cells are often selected as the number employed, as such a battery can be conveniently charged at any ordinary direct-current electric light station, which are usually designed to supply current at 100 volts or more. It is as well that every car should be provided with a switch which can be used for interrupting all connection between the cells and the motors of the vehicle while charging, as otherwise somebody moving the controller might cause the car to start off suddenly at full speed and take a header into a wall or a piece of moving machinery. A lock for the controller is nearly as good.

It must be borne in mind in charging a battery of accumulators that the voltage required is in excess of that which the cells give when discharging. Thus a forty-four cell battery will give about eighty-eight to ninety volts for car propulsion, but it will require something over one hundred volts to charge it. The variable resistance mentioned above should be inserted in the circuit so as to enable the amount of current charged into the cells to be controlled. When it is desired to economise the time occupied in charging, a higher rate may be permitted during the earlier stages, the amount being gradually diminished towards the end of the charge. The approach of the completion of the charge is marked by the 'gasing' of the cells—that is, the dilute acid fizzes more or less like soda water. The strength of the acid also increases as the cells are charged, and the increase may be used to show when charging

is complete. A small glass vessel called a hydrometer, which can be inserted into the acid, and indicates its specific gravity, is used for this purpose.

Of course batteries can be charged from any direct-current (not alternating) electric lighting circuit that gives the necessary pressure : thus the forty-four-cell battery could be charged from a two-hundred-volt circuit, but a great deal of resistance would have to be used in series with the battery, and it consumes

H.R.H. the Prince of Wales' Electric Brougham
(City & Suburban Electric Carriage Co., Ltd.)

Extreme length, 10 ft. 10½ in.

energy, thus making the process an expensive one. The cost would be double that of charging from a hundred-volt circuit.

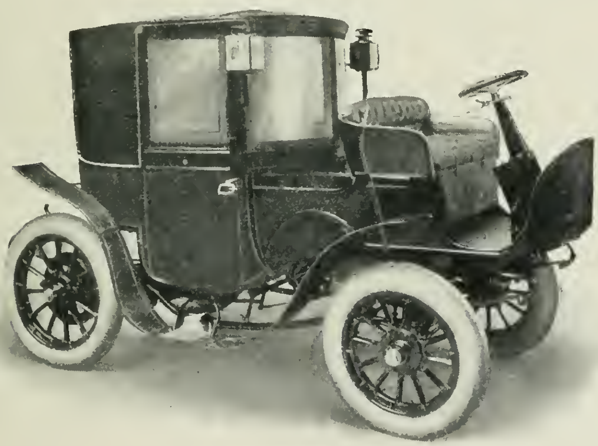
In what has already been said, we have dealt with our subject in a more or less general way, with a view of giving an all-round insight into the questions relating to this type of automobile. And now a few words may be devoted to the

characteristic features, position, and prospects of the electric vehicle.

In the early days of these machines, many attempts were made to utilise them for long distance touring, and it was hoped by many makers that, with improved charging facilities throughout the country, electromobiles would take the place which is now held to so great an extent by petrol cars. Some vehicles were even built for racing. Since then, however, experience has shown that, although capable of doing remarkable performances under special conditions, the useful field for the electromobile is limited, though in that field it easily holds its own against all rival systems. The accumulators, besides being heavy, not only need frequent recharging, but none of those as yet produced are sufficiently durable to make the upkeep of an electric carriage cheap in comparison with that of other self-propelled vehicles. They also need a greater amount of care, and occasionally highly skilled attention, than the owner himself is either willing or often able to give them. Hence the electric vehicle is a luxury which is only within the reach of those, in the country, who have their own electric-lighting plants, or, in the towns, of those who can avail themselves of such special facilities as may be provided for them there.

An enormous amount of attention has been paid to the question by a few large companies in London, with the result that persons who purchase cars from them can have their vehicles stored, cleaned, recharged, and kept in thorough order by competent men. The depôts organised and equipped for this purpose have been opened in the immediate vicinity of the owners' residences, so that the machines are at all times ready for immediate use. According to the latest fixed tariff, a charge of 150*l.* per annum is made for storage, cleaning &c., and a further charge at the rate of 6*d.* per mile—of which about half represents actual cost of replacing battery plates—is made for recharging the battery whenever required, and for continuously maintaining it in thorough order. Competent drivers can also be obtained for about 10*s.* per day or 50*s.* per week.

Including the driver, the cost of keeping one of these electric vehicles, assuming that it runs about 500 miles per month—and this is found to be the average—amounts to about 500*l.* per annum, which to the automobilist appears to be a somewhat high figure. This is, however, about what it now costs to keep a pair-horse carriage in London, and the comfort, capabilities, and convenience of the electromobile are so vastly greater, that, in a remarkably short space of time, it has



Three-seated 'Alexandra' Electric Carriage
(City & Suburban Electric Carriage Co., Ltd.)

Extreme length, 10 ft. 10½ in.

become quite a familiar feature of our streets, between 300 and 400 being already in use. The distances travelled by these cars is extraordinary, it being no uncommon thing for them to average thirty miles daily. They are, moreover, very speedy, besides being thoroughly safe and trustworthy.

Concerning the future prospects of the electric carriage, it may safely be said that it is destined to become more and more used as time goes on in the special field which has already been

indicated. It is also reasonable to suppose that further improvements will continue to be made in connection with the accumulators, and that the cost of maintaining them will correspondingly decrease. It is of course possible, too, that the many-times-promised 'perfect' battery *may* make its appearance, and that the whole aspect of electric vehicles will be completely changed; but it is generally agreed amongst those qualified to express an opinion that there are many other unlooked-for things that are more likely to happen than that.

In conclusion, it may be said that the electric vehicle of to-day, used in its proper sphere, has many very great advantages over any other form of carriage. For one thing it is comparatively 'fool-proof.' It is practically noiseless, or can be made so. It has great flexibility and changes from one speed to another without jolt, jerk, or jar. The driver is not compelled to keep his eye on a water-gauge or the contents of a fuel tank, to manipulate change-speed gears, grind in valves, or replace ignition-plugs. All he need trouble about is his steering gear, his brakes, and the position of his controller, with an occasional glance at his voltmeter and ammeter. Above all, the electromobile has no odour of its own, is entirely free from vibration of any kind, and is always ready to make an immediate start without waiting for an engine to be 'wound up' or a boiler to be 'fired.'

CHAPTER XIV

MOTOR CYCLES

BY THE EDITOR OF THE 'MOTOR-CAR JOURNAL' AND F. STRAIGHT

To those who can realise, by actual possession, the pleasures of the motor-car, this chapter will be of little interest. But there are many aspiring motorists to whom the original cost of a car, or its maintenance when purchased, is a barrier to ownership. Hence the favour with which motor cycles are regarded, and the growing importance they are attaining in the automobile movement. The familiar forms are the tricycle, quadricycle, and the bicycle, the latter having rapidly come to the front, to the apparent supersession of the more cumbersome type of motor cycle. With regard to the permanent popularity of either form nothing need be said, individual preference being left to settle the question. But it may be pointed out that the bicycle is more conveniently adapted for storing where space is limited, and that it is to this kind of motor cycle that the attention of makers is being mostly directed at the present time.

There is no doubt that the motor cycle will prove an effective educational medium in connection with automobilism, for the intending motorist will be able to learn all about petrol engines at a much less cost than is demanded by the purchase of a motor-car. The experience thus gained will be extremely useful should the motor cyclist ultimately become the owner of a larger vehicle, while those who begin with motor cycles will probably enter the ranks of motor-car owners after they have realised the pleasures and delights of automobilism—

whether with the cheaper or the more expensive form. Thus the cycle will do much to popularise motoring.

For all practical purposes the motor-cycle comes under the Motor-car Act of 1896 and 1903 and the Local Government Board regulations, by which its speed is restricted to twenty miles an hour. A motor-cycle is generally understood to mean a motor-car designed to travel on not more than three wheels, and weighing, unladen, not more than 3 cwt. Under this Act it is necessary, before using a motor-cycle on the road, to have it registered with a County Borough or Council, for which a fee of 5*s.* has to be paid. A number is then allotted to the machine, which must be exhibited in front and behind by means of a metal plate, and with letters and figures of a specified size. Either of these plates must be illuminated at night. Besides the registration, the rider of the machine must himself take out a licence to drive, which licence must be obtained from the County Borough or Council in which he resides. This licence will also cost him 5*s.*, and remains in force for twelve months, when it must be renewed. The possession of a licence to drive a motor-car entitles the holder to drive a motor-cycle, but a licence to drive a motor-cycle does not give authority to drive a motor-car. Restive horses and policemen must also be respected, and the motor cyclist must halt upon a signal from the driver of the former or the raising of the hand of the latter. Lights must be carried as on ordinary bicycles. In addition to observing these regulations, the owners of motor quadricycles, tricycles, or bicycles must take out the Inland Revenue licences —at the cost of 2*l.* 2*s.* in the case of the quadricycle, and of 15*s.* in that of the others. If a trailer be used, an additional tax of 15*s.* will have to be paid, making 30*s.* in all for the cycle and trailer. Efficient brakes must also be provided.

Apart from machines now regarded as curiosities, the motor tricycle of MM. de Dion and Bouton was the most successful form of vehicle introduced after the adaptation of the internal combustion engine to road locomotion. The first made had a small $\frac{3}{4}$-h.-p. motor fixed to the rear axle, the carburetter

being placed behind the main down tube to the frame. The size of the motor was gradually increased until we now find tricycles in ordinary use with air-cooled motors of $2\frac{3}{4}$-h.-p. capacity. Of a similar design was the Phœbus tricycle fitted with the Aster motor. It differed only in minor points from other machines, and in the use of copper radiating gills tightly fixed on the cylinder of the motor, the advantage of which (as Mr. Worby Beaumont remarks) is not very apparent. The Beeston tricycle was the first of the kind English-made throughout, but the Ariel motor tricycle was the first really successful English machine. It shows several variations in design from the original De Dion. Notably, the motor, instead of being placed to the rear of the back axle, is placed forward of it. A single case fills up the whole of the space in the main frame, and contains the battery, carburetter, and petrol tank. There are a few other motor tricycles, but their main features are on the lines of the above. Of late years there has sprung up a demand for some sort of attachment by which a rider can take a passenger out with him, and various forms of attachments have been placed upon the market, viz. fore-carriages, side-carriages, and trailers. The most popular of these is the fore-carriage or 'trimo' as it is frequently called, the basket or body of which is detachable, so that the machine can be ridden as a tricycle, or by detaching one wheel it can be converted into a motor bicycle. The drawback to this type when there have been two passengers has hitherto been overheating, but many of these machines are now fitted with water cooling, which should overcome this difficulty; and with a two-speed gear fitted, such a machine would be capable of taking two passengers up any average hill. The objection to a side-carriage is the difficulty of riding the machine when there is only one passenger, the general practice being to sit in the side carriage and steer the machine, which it must be admitted is not very comfortable. Trailers have lost their popularity, and this is not to be wondered at, for there is always the fear of the bicycle having a side slip, which of course would mean trouble for the occupant of the trailer.

Passing to motor bicycles, they are of such recent development that they really have no history. Although Daimler designed a motor bicycle in 1885, it was not till eight or nine years ago that serious and sustained efforts were made to perfect the petrol motor bicycle. In this connection the Wulfmuller was a pioneer. It had a double-cylinder motor, driving the hind wheel, and was a cumbersome and unsuccessful machine. The Werner occupied for some years a similar position among motor bicycles to the De Dion among motor tricycles, but within the last two or three years English manufacturers have come rapidly to the front; in fact, four out of the seven motor bicycles which succeeded in gaining first-class certificates in the Auto-Cycle Club's 1,000 miles Reliability Trials in 1903, were of English manufacture throughout including the engines. These trials lasted a fortnight, and the weather was of the most wretched description, with rain day after day; it therefore speaks well for the reliability of the present motor bicycle that seven machines should have passed successfully such a series of trials without being attended to in any way beyond having daily supplies of petrol and lubricating oil. The names may be mentioned: they were the Bat, Bradbury, Chase, Kerry, King, Ormonde, and Werner. While gear driving has been universally adopted in the tricycle, most motor bicycles have been adapted for belt driving. Several, however, are driven by chains, and in the Starley and Swift machines we have a worm-driven single-track machine. The engine is placed in a vertical position, and behind it is bolted a two-speed gear box containing also the worm and pinion. On the end of the pinion shaft is keyed a chain wheel which drives by means of a chain to the rear hub. The gear enables a free engine to be provided between the high and low gear, which greatly facilitates starting and running at slow speed in traffic.

The first point of interest in connection with motor bicycles is the position of the engine, and owing to the practice in the early Werner machines, where the motor was fixed above the front wheel, it was long thought that the weight of the engine should be placed as high upon the bicycle as

possible. That location, it was claimed, was necessary to ensure the stability of the machine, and to minimise the danger of side-slip. Experience, however, has shown that this is not so essential, and there are now a score or more of motor bicycles only two of which have the engine above the wheels. In the majority of cases, however, the engine is placed halfway between the two wheels in a vertical position, thus bringing the centre of gravity very low. A low-down position between the wheels is being generally adopted, as tending to reduce the vibration and lessen the liability to side-slip.

The subject of side-slip is one of the greatest interest to all motor cyclists, and the position of the motor has been variously located, with a view of minimising its occurrence. It is generally acknowledged that motor bicycles are not more prone to dangerous side slips than are ordinary leg-propelled cycles. On a slippery road with the ordinary bicycle there is only the rider and the bicycle in question, but in the case of the motor bicycle the engine makes its presence felt, lessening that instantaneous and automatic control so essential for safety. The Minerva engine has been adopted on many bicycles. It is now of 2, $2\frac{3}{4}$ and $3\frac{1}{2}$ h.-p.; the carburetter has been redesigned, and is known as the M.-L., or Minerva-Longuemare. It is of the spray type, now most generally used, and the petrol consumption stated to be about one pint for twelve to fourteen miles on level roads. In the Minerva motor bicycle the engine is fixed below the bottom tube of the frame, slightly forward of the bottom bracket in either the inclined or vertical positions. The Excelsior was one of the first British motor bicycles in which the Minerva engine and system was adopted; they now, however, fit an English-made engine, the M.-M.-C. The extensive employment of the Minerva motor was one of the most astonishing features of the early development in motor bicycles. It is noteworthy, however, that several leading makers, whilst using the Minerva, have introduced in connection with it a number of special features which considerably facilitate the handling of the machine.

In the Quadrant motor-cycle matters are simplified by one lever being made to control the switch, open and close the exhaust valve, regulate the gas supply, and vary the sparking. This reduction of the number of levers is undoubtedly a step in the right direction. The gas can be supplied in varying quantities, as usual, and is regulated by the lever from the lowest to the fullest supply before the advance of the sparking begins. Then when a greater speed is sought, it is obtained by the advance of the sparking, according to the pace desired, or in other words, the explosions are more rapid, the quantity of gas used being, of course, the full charge. In the ordinary arrangement it is possible to vary the supply of gas allowed to pass to the explosion chamber with the sparking lever at any point. An exhaust-valve lifter is fitted if desired.

In the Phœnix motor bicycle, the Minerva engine is adopted with two or three ingenious additions. The switch is controlled from the handle-bar, the electrical contact being arranged near the engine. The switch lever is so arranged that when further moved the exhaust-valve is lifted. In the same bicycle, the space between the down diagonal and the rear wheel is used for a specially shaped tank for petrol, giving a total available supply sufficient for a run of 200 miles. The Ariel Co., one of the pioneers of the British built throughout motor cycle, maintain their standard of excellence in the motor bicycle which they have placed upon the market. The R. and P., Bradbury, and Rover machines have their engines in a vertical position, and the crank chamber forms part of the frame. In the Marsh motor bicycle (which is of American design), the engine is built into the frame, the main down tube of the bicycle joining the top of the combustion chamber. The Chase machine, which is of English design and construction, has very rapidly come to the front as one of the leading motor bicycles. The engine is built into the frame well forward, giving perfect balance, with ample pedal clearance and narrow tread. The Ormonde motor bicycle is now supplied in two patterns, the old, with the engine behind the down tube and a long

wheel base, and a new pattern with the engine in a vertical position in front of the bracket. These machines are fitted with a very useful petrol indicator, a float in the tank causing a spiral to turn, thus showing the actual quantity of spirit remaining.

Power transmission, a subject already incidentally mentioned, is an important point with regard to motor bicycles.

Belt-driving was originally the only medium considered, as it overcomes much of the vibration, although the tendency of the belt to slip is an obvious disadvantage. The **V** section belt is the type most generally used, whilst some makes of machines, notably the F.-N., have the broad flat belt, and others the twisted belt, the slack in which can be taken up by increasing the twists. Even with this, however, there are disadvantages, and when riding in wet weather on sandy roads we have known it to grind the groove of the pulley-wheel, slipping of the belt naturally resulting. Although powdered resin may be a temporary cure for this, the best way is to untwist the belt and twist it in the reverse direction.

In the Singer motor bicycle the manufacturers are now departing from their custom of locating the whole of the mechanism in the driving wheel, and the 3 h.-p. engine is carried vertically in a frame of special construction. A spray type of carburetter and magneto ignition are employed, and one small lever suffices to effect the whole of the control. These machines are fitted with either belt, gear, or chain transmission. In the Primus two-cycle motor, the power is transmitted from a pulley connected with the outside fly wheel direct on to the tyre of the front wheel. It is claimed by the advocates of this system that no extra wear on the tyre results. Latterly, chains or cog-wheels have been experimented with, but machines with this kind of driving cannot as yet be said to have been thoroughly tested, and it remains to be seen whether chain or gear driving will obviate the drawbacks to the belt without introducing disadvantages of their own. Chains are employed in the Humber motor bicycle, a friction disc faced with leather being introduced to slip slightly when undue pressure falls

on the chain. In this case the motor is an essential part of the frame, and forms the bottom tube.

No final judgment can be given on this question of transmission, for like everything else about motor bicycles, the whole subject is in a state of transition. Bnt the difficulty is especially great when we find experts divided. There are two gentlemen of the name of Craig who have each devoted much attention to this subject. Mr. A. Craig of Putney tells us that he considers 'that in spite of slipping and breaking, belt transmission is the best. It is simplest and cheapest, and under good conditions an almost ideal drive.' He prefers a flat belt, of at least one inch width, and a jockey pulley on ball bearings. The jockey pulley is always abused because its purpose is misunderstood. It is not meant to jam the belt up tight, but to make it hug as much as possible of the circumference of the driving pulley. Twisted leather belts are in his opinion a nuisance. On the other hand, Mr. A. Craig of Coventry says, 'It has been a matter of surprise that the belt should have survived so long as a means of transmission in motor bicycles. Probably, the belt drive will eventually lose favour except for low-powered machines, and some form of chain or gear drive take its place.' Sir Roger de Coverley would probably have called this a case of 'much to be said on both sides,' and suggested that experience should determine the result. Personally the writer is in favour of chain transmission. During the very wet season of 1903 he rode a $2\frac{3}{4}$ h.-p. Humber, and throughout never had any trouble whatever with the chains, although the machine was ridden in all kinds of weather.

Future developments in connection with motor bicycles will no doubt be concerned with spring frames and two-speed gears. Already some interesting work in these directions has been done, and in the Bat spring frame bicycle we have a machine that is not only comfortable but which reduces vibration to a minimum. This machine went successfully through the Auto-Cycle Club's 1,000 miles Reliability Trials in the worst possible weather, securing a first-class certificate. One

drawback to the use of the motor bicycle in hilly districts is that the motor only gives out its full power when running at the normal speed. When going uphill the speed of the motor naturally slackens, and consequently the engine does not give off its standard capacity. To overcome this difficulty inventors are studying the matter from two different points of view. Some are in favour of the use of motors of higher capacity than those now in general use, while others are experimenting with two-speed gears, arguing that it is better to have a small engine kept steadily running, and so developing its full power notwithstanding the gradient, the low gear being used for hill climbing. The Starley and the Phœnix motor bicycles are fitted with two-speed gears, and, indeed, many of the leading manufacturers fit them if desired. The Phoenix two-speed gear is contained in the back hub, and the power from the engine to the two-speed gear is transmitted through a friction clutch. A lever placed on the top tube of the machine when pulled right back engages the high gear, when placed vertically gives a free engine, enabling it to be started with a handle like a car, and when pushed further forward the low gear gradually engages by means of a friction clutch, so that the machine can be started even on an incline. The gear being in the back wheel only travels at the same speed as that wheel; therefore, going very slowly, it is practically noiseless.

Motor cycling, although hitherto enjoyed only by the male sex, is likely to prove attractive to ladies in the future, and already machines have been specially introduced for their benefit. The motor is placed below the bottom tube, and ample protection is afforded in the way of dress-guards, &c.

The novice need have no fear of his motor bicycle. It is not a haphazard aggregation of bits of metal, and although there are bicycle motors composed of more than 140 separate pieces, they present no unfathomable mystery. But the mechanism requires understanding, and we advise the intending motor cyclist carefully to study the chapters on Petrol Engines, Ignition, &c., in this book. A clear understanding of these

will conduce to the pleasure of early experiences, which otherwise may be more varied than delightful. Even then he will have much to learn before he can qualify for a police certificate as to his ability to attain a speed above the legal limit. Diplomas for obstruction can be more easily obtained in public thoroughfares, hence the advisability of early runs being taken in secluded districts.

Before setting out, the cycle should be carefully examined and the engine tried. It is necessary, too, to be assured that the tool-bag contains the requisite equipment of tools and spare parts. We can remember on one occasion a friend of ours had glanced over the mechanism of his cycle, and had made sure that everything was satisfactory. Removing the interrupter he retired to clean his hands after the operation. Returning to his bicycle, he exerted himself on the pedals, but no explosion occurred. Dismounting he again overhauled the machine, spent ten minutes or so in investigation, and was ultimately warned by a constable for creating an obstruction in the roadway. He tried everything except, let us hope, profanity, and was preparing to seek friendly aid, when, casually putting his hand in his pocket, he discovered the interrupter plug, and his troubles were quickly over. Many of the so-called failures of motor cycles are due to equally trivial causes.

There is nothing consistent about our English climate—except its variability; and the motor cycle must rise superior to changeable climatic conditions. During cold weather those riders whose machines are fitted with surface carburetters have often been troubled with regard to the 'mixture,' and even in the summer-time, when riding over very bumpy roads, the petrol in the carburetter will be thrown about, giving off more vapour than is required, and affecting the running of the motor. The only way to overcome this difficulty is by continually controlling the air inlet. A number of riders of the 1901 Werner got over the difficulty in winter by warming the carburetter by means of a branch from the exhaust-box, a flexible tube being used. It was not, however, an easy matter on this machine, the motor being on the head stem of the bicycle, and moving

independently of the carburetter. Spray-type automatic carburetters are most generally used; these have certain advantages over the surface type, but with their use the necessity of seeing that no dirt or foreign matter gets into the petrol tank becomes an urgent question.

In the majority of motor cycles electrical ignition of the jump spark type is adopted, although in a few cases the magneto arrangement is being employed. The escape of the electric current or the premature running down of the battery is one frequent cause of trouble where dry batteries or accumulators are used. It may result from loose electrical connections, bad contacts, and short circuits. If two of the terminals of the wires get connected with a film of moisture, a short circuit is the inevitable outcome; hence extreme care should be taken when riding for a considerable time in the rain. The rider should frequently test the accumulator with a voltmeter to see that the necessary charge is there, or if a dry battery is used, test the amperemeter; he should always carry a spare battery, and have the accumulator recharged before it reaches the point of exhaustion. It is advisable to give new accumulators a charge every month or six weeks whether in use or not. The acid should always be kept up to its correct strength (1·190 when battery shows 4 volts). There may be trouble through the platinum points of the contact-breaker getting worn down or dirty with oil, or the platinum, on what is known as the 'trembler' (whether it trembles or not is a debatable point), becomes loose and causes jumpy progression of the machine. The remedies are obvious: clean the contact points or replace with a new 'trembler.' The simple 'make and break' with a non-trembler coil is considered by many to be the best, but this requires careful adjustment, or much waste of current may take place. This is best done with the engine running, and if the platinum screw is as far from the blade as possible without misfiring the minimum current is being used.

Sparking plugs are often a source of worry, but a friend has travelled 11,000 miles and only required three plugs. Apart

from an absolute fracture of the porcelain, the main cause of stoppage is owing to the plug inside the cylinder becoming fouled with carbon through an imperfect mixture being used. Often too much lubricating oil is inserted in the crank-case. This then gets over the top of the piston and is burnt up when an explosion takes place, leaving a heavy deposit of soot. When this occurs the plug should be removed and the points cleaned.

In long runs, when the motor becomes heated, the inlet valve-stem may stick on its seat through oil or the bye-products of the explosion getting on to the stems. A little petrol squirted by an ordinary bicycle oil-can on to the stem will generally overcome the difficulty. Another plan is to take out the inlet-valve and wash the stem with the finest black-lead and petrol. On evaporation the stem will be left well coated with black-lead, which is a very good lubricant where there is great heat.

In order that the motor should work well it is necessary to have good compression. In the four-cycle engine the charge is compressed every second stroke of the piston towards the head of the cylinder. To obtain good compression, which is the forcing of the mixture into a smaller area, there must be no leaks, and the cylinder, piston, and valves must be perfectly tight. Otherwise, when the mixture is reduced in volume it will leak out and there will be poor compression, with the result that the motor will not give anything like its proper power, the force of the explosion being greatly reduced. Such working, too, is not economical. It is necessary, therefore, to see that there are absolutely no leaks, and the points where leaking can occur are as follows :—(1) the inlet-valve ; (2) at the sparking plug ; (3) around the piston-rings ; (4) at the exhaust-valve ; (5) at the point between the explosion chamber and the cylinder-top, where the cylinder-head is fitted on to the cylinder. Every little leak, no matter how small, means a loss of power. The valves should be examined first, viz. the inlet and the exhaust. They should be packed with suitable washers, and it should be seen that they set firmly on their

seats. If there is any wearing of the metal the valves should be ground until the surfaces are perfectly smooth, so that an absolutely tight joint is made on the seating. One of the most important places to look for leaks is at the piston-rings. These are set in grooves on the side of the piston, and make it fit tightly in the cylinder. On account of the excessively high temperature inside the cylinder, which dries up the lubrication, the rings may not run well, and will allow power to be lost, particularly if the engine has been out of use for a time. A little paraffin dropped into the cylinder through the compression tap will ensure free and proper operation of the piston-rings. The petrol motor is a very economical producer of power, unless something like a leak or bad ignition is taking place, and while really simpler than a steam engine, it seems more difficult of comprehension to the budding motorist.

The owner of a motor cycle who expects to use it constantly without previous experience, and not run up against various sources of stoppage and breakage, will find himself mistaken. A frequent experience is to run the whole gamut of troubles, and thus by actual knowledge having learned to fix all the various parts, the operator is qualified to take care of his machine. These troubles occur for three principal reasons. First, the ordinary individual who buys a motor cycle will not make a careful study of the manner in which the machine is built and how it works, but prefers to tackle it on the 'hit and miss' plan and learn by hard knocks and experience. Second, carelessness and the disinclination many persons have to take proper care of a piece of machinery. A motor cycle, however, cannot be expected to run properly unless it receives regular attention. Third, from accidents pure and simple. As already explained, a great deal of trouble might be avoided if riders would only take the pains to understand the principle of the machine before attempting long journeys.

(This chapter was originally written by the Editor of the 'Motor-Car Journal,' but for the present edition Mr. F. Straight, Secretary of the Auto-Cycle Club, has kindly revised it and made several important additions.)

CHAPTER XV

MOTOR-DRIVING

By S. F. Edge and Charles Jarrott

The motor-car, when in the hands of a careful and experienced driver, is admittedly the safest form of vehicle on the road, the chief reason for this being the rapidity with which it can be stopped, even when travelling at high speeds, and also the ease with which under the same conditions it can be diverted from its course into the direction desired by the driver. These two points are known to nearly every well-informed person, and the knowledge really constitutes a danger to the unaccustomed controller of a car, as road conditions may entirely upset all the previous experience of the novice, and the apparently great simplicity of control inspiring confidence at much too early a stage of his novitiate, he may become a most dangerous user of the road, although driving the simplest form, or rather the most controllable form, of road vehicle.

Every action of starting, stopping, changing, and diverting should be absolutely automatic, and until this has become so slow speeds only should be attempted. A man may be perfectly able to perform all the special driving functions when not flurried, and when his attention is not disturbed by exciting events, but he may become hopelessly involved at the very moment when the greatest skill and judgment are required from him—for instance, when in an emergency the pedal brake ought to be applied, instead of pressing down this brake, which would at once stop the vehicle, he may hurriedly press down the accelerator pedal, which has the effect of increasing the

speed, and thus, possibly, an accident of a most serious nature results.

Again, nothing but practical experience will teach a novice the correct speed to drive round a given curve, for the conditions of the road alone may cause a speed perfectly safe on a dry day to be absolutely dangerous on a wet day; probably one quarter the speed possible on a dry day would be too fast and dangerous when the road is wet.

Greasy roads are the greatest danger of all to the novice, and yet when the driver has acquired enough skill to gauge the correct speed to drive over them, and keeps himself within the limit of that speed, there is little or no fear of mishap. Here, again, however, even an experienced driver is sometimes inclined to run the risk of driving the car at a greater speed than the road-surface warrants; and consequently if brakes have to be applied suddenly, and the car pulled up in a short space, there is a possibility of a bad side-slip. The great point on greasy roads is to drive cautiously.

It is an exceedingly awkward and dangerous occurrence when a car runs backwards down a hill, through, perhaps, a chain breaking, or the driver missing the gear in changing speed. This may possibly happen before the novice has ever thought of learning to drive backwards, and the lesson under this nerve-shattering circumstance probably results in his having a big repair bill to face, to say nothing of doctors' bills.

Perhaps in endeavouring to initiate the beginner into the art and apparent mystery of controlling and driving a motor-car, it would be as well to start from the beginning. We will assume that the car has arrived home and everything is ready to set off for the first drive. Although we wish to give all possible hints in this direction, it is well to remember that the greatest safeguard, when you take your first lesson, is to have on the car with you a really good driver so that he may be ready to act if a combination of circumstances should require a rapidity of decision and action that cannot have been acquired by the novice.

Assuming that the vehicle is in perfect condition for use and the engine has been set going, the first thing to do is to examine the ways and means of starting the carriage either forward or backward, to ascertain how to stop it when desired, and steer it from side to side or round a corner, or to avoid an obstacle. We will suppose that the vehicle is of the Panhard type, with wheel steering and single lever at the right-hand side, giving the speeds forward and reverse. On taking a position in the driver's seat with one foot on each side of the steering column, each foot lightly resting on the two driving pedals, it will be found that the left pedal when pressed down disconnects the engine from the driving mechanism, whilst the right one also does this, but at the same time applies a powerful brake to arrest the motion of the vehicle.

Slightly to the right of the right-hand pedal will be found a smaller pedal set somewhat higher than the other two. This is called the 'accelerator pedal,' and its function is to hold out the governor of the engine and cause it to run at a greatly increased velocity, and so force the vehicle to exceed its regulated speeds. The use and misuse of this valuable adjunct to the motor-car engine will be dealt with later.

The change-speed lever is on the right hand, and by its side is another notched lever which applies a band brake to each of the rear-wheel hubs; also when applied it disconnects the engine from the driving mechanism, so that when one wishes to stop, this brake lever first disconnects the engine and then retards the momentum of the car, thus performing the same function as the two pedals operated by the feet and referred to above. With these general points carefully noted, a start may be made, and we will imagine that the car has been standing as it should be when the engine is running, i.e. with the speed lever in the neutral notch and the side brakes on, and thus, of course, the engine disconnected from the gear.

First Speed.—First place the left foot on the left pedal, press this down as far as it will go and hold it there. Then take off the side-brake lever, move the speed lever forward one

notch--that is, to the first or low speed—and slowly lift the left foot until you feel the engine beginning to move the car. Immediately it does this, if only for a yard or two, press the left pedal down again, so as to get thoroughly accustomed to the feeling of the car moving forward with its own power and yet stopping immediately the pedal for disconnecting the power is pressed down.

When once confidence is acquired, and the novice feels that the car is quite under his control, longer distances, say fifty feet at a time, may be attempted; but as it will be obvious that in this distance some momentum will have been attained, and that even though the left pedal is pressed down the carriage still rolls on, opportunity has now come for making use of the right pedal. This being pressed down gradually by the right foot, at the same time still keeping the left pedal down, applies the band brake and so stops the car.

Second Speed.—Having now thoroughly mastered starting and stopping on the low speed, a change may be made into the second speed. To accomplish this, first get the vehicle running as fast as possible on the first speed, then press down the left pedal quickly, push the speed lever firmly into the second forward notch, and lift up the left pedal gently as when starting. You are now on the second speed, which you will no doubt observe is considerably faster than the lower speed, and the novice should familiarise himself with this in the same way as on the first speed, i.e. letting the car run short distances and thus becoming accustomed to the speed. Keep on the low and second speeds until you feel thoroughly at home and confident that the car will do that which you mechanically direct it to do. Remember that with a motor-car the driver controls the vehicle, and in this it differs from a horse-drawn vehicle, in which the driver is often at the mercy of the animal, to be pulled here, backed there, or upset altogether, should this chance to please the noble quadruped.

Third Speed.—The third speed may now be used, and you obtain this under exactly the same circumstances and in

exactly the same way as set out in the explanation of changing from the first to the second speed. It will be well if some long runs be taken at this stage, no speed higher than the third being attempted. When this stage is reached, it will be found very much better to take four or five drives of ten miles each, with half an hour or an hour's stoppage between, rather than one continuous drive of forty or fifty miles. Much more rapid progress will be made in this way, and the mental and physical strain is then not noticed, whereas if one long ride is attempted straight off, the novice, when he gets down from the car, will feel uncomfortably tired and exhausted. The next day, if possible, more driving should be undertaken, but this time on the second speed, first directing the steering with one hand and then with the other, so that perfect control can be exercised with either hand, the hand that is more or less at liberty being engaged in taking articles out of the pocket, &c., adjusting the lubricators, pumping oil into the cylinders, and other small details of this sort, which at times it is expedient to do when actually on a journey. One can never feel at all secure until either hand will do all that is necessary with regard to steering. When one is thoroughly familiar with steering with one hand on the second speed, then higher speed can be attempted.

How to Change Speed properly.—In changing speeds there are various things to be avoided, and the learner will very quickly realise that it is most difficult, if not well nigh impossible, to change speed without withdrawing the clutch; which operation is performed by pressing down the left pedal. In any case if he does succeed in the attempt, it will be at the expense of a great deal of noise and damage to the teeth of the gear-wheels. Under all circumstances the teeth are made to engage with one movement, and if at the beginning it is found that when attempting to change speed a grinding noise is heard, it is best to stop the car completely and not persevere, but change the speed quietly with the car standing stationary. When this has been done, and it is brought absolutely home to the learner that the speed can be changed, then he must revert

to the lower speed and begin all over again, until he can change each speed easily and quietly while the car is running; it is only a question of practice. The clutch-pedal must be pressed down firmly and decisively without haste or any violent force.

There is another important factor in regard to changing speeds which must be considered, and that is, to change speed at the proper time in relation to the speed at which the car itself is travelling. The usual mistakes on the part of the novice in changing speed are :—

1. To change to a higher speed too soon.

2. After withdrawing the clutch, not changing speed soon enough, thus allowing the carriage to run too slowly to enable him to change on to a higher speed.

3. Often in ascending hills he does not change to the next lower speed quickly enough. It is always well to remember that in going uphill the engine is best when kept at its maximum rate of speed; if it drops below this, change to a lower gear at once. This is especially important if you are driving a powerful car, as the strain thrown on the clutch when driving on too high a gear will not improve that very important item of the car's anatomy.

A very good formula to follow in regard to changing speeds is to continue on the speed on which you are running until the engine cuts out or shows signs of extra vibration or noise, which will at once indicate to you that it is running faster than it ought, and that it is desirable to change on to the next speed. This will ensure there being a good run on the car, and that the next higher speed will take up the run and increase the pace.

In changing to a lower speed, it is always well to change in good time directly the car exhibits the slightest sign of flagging on the speed it is then running on, as one must remember that immediately the clutch is withdrawn on an upgrade the car starts slowing, and if one does not change quickly, it will not pull even on the next lower speed. The result of this will be that, instead of changing back to one speed,

the driver will have to change down two speeds to keep the car running properly. It is therefore highly necessary, before trying long drives in a hilly country, that this point should be thoroughly mastered. The same remarks apply in ordinary driving. It is always well to keep within the power of the engine, and after having stopped or slowed down it is advisable to change back to a lower speed so as to ensure the engine plenty of power to start the car again.

Accelerator.—It would perhaps be as well here to explain the use of the third pedal referred to before as the 'accelerator pedal.' While not essential to the proper running of the car, it can be made of considerable use in driving.

The type of motor carriage we have described is fitted with an engine which governs out at approximately 750 to 800 revolutions a minute. If, however, the governor is held up—and this is what the accelerator pedal accomplishes—of course the engine speed is considerably increased and the speed of the car is increased accordingly; but though the accelerator pedal is beneficial in the hands of a careful and considerate driver, it can be abused to the damage of the engine and gear in the hands of a rough or careless driver.

To race the engine on any and every conceivable occasion is obviously improper; but it will be found that to accelerate a little when wishing to change (but before doing so), especially when going uphill, will assist very materially in accomplishing the change of speed successfully.

Overrunning the Engine.—We will suppose that you are running down a steep hill with the speed lever set in the third speed—with the left pedal down and the motor consequently disconnected—and this third speed gives, say, a rate of twenty miles an hour. The car, however, from its own momentum and the force of gravity, may be running at twenty-five miles an hour, and to let the clutch in then throws a very unfair strain on the engine. It must be remembered that the engine has to drive the car and not the car the engine, which if caused to rotate at a much greater speed than that for which it was

constructed may result in a serious breakage. Therefore do not let the clutch in until the speed of the car is sufficiently reduced to give the engine some work to do when the pedal is lifted up.

Starting for a Drive.—There are many points which require to be thought over when starting for a drive, so as to make sure that everything is in order and that the necessary spare parts are carried. Although it seems a formidable list, it is curious how very quickly one gets used to running mentally over all these items, and after a time never forgetting anything.

The main points to be thought of are to make certain that the tanks are full of petrol. A good way of dealing with this matter is to fill up with petrol whenever there is a suitable opportunity, as this ensures the car always being ready to travel its maximum distance without any special preparation. It is then necessary to see that the water tanks are full, that your working and spare accumulators are fully charged, that all the lubricators and grease cups are absolutely full, and that some spare lubricating oil is carried. Also a number of spare parts should be taken, such as spare exhaust-valve and spring, spare inlet-valve complete, three spare sparking plugs, spare inner tubes and repair outfit. Besides these,

A large screw wrench.
Small pocket wrench.
Long screwdriver.
Small screwdriver.
Pair of cutting pliers.
Pair of gas pliers.
Two files, medium size.
Coil of copper and steel wire.
Oil-can with long nozzle.
Small cold chisel.

Supposing all then is ready, the next thing to do is to start the engine, and the points to be gone through are as follows :—

1. Turn on petrol.
2. Switch on ignition.

3. See that the lever to the commutator is retarded as far as possible. (This is done to make certain that no back-fire will occur.)

4. Turn on lubricator.

5. Start engine.

Before Starting the Engine.—One of the most important things to do before attempting to start the engine is to see that the speed lever is in the out-of-gear notch. The importance of this cannot be emphasised too much. We have seen a number of accidents of a more or less serious nature result from the neglect of this precaution. We remember particularly on one occasion a friend started up a car with the speed lever in the forward notch but with the side brakes on, thus holding out the cone. The vibration of the engine shook the brake lever out of its notch, in jumped the cone, and off jumped the car. As this took place on the edge of a very high cliff within a few yards from the brink, observers went through the agonising experience of seeing a trusty little car and an agitated driver struggling for supremacy—the one to plunge over the edge into space and the other to prevent this catastrophe. Luckily the fly-wheel of the engine struck on a mound and stopped the car with the two front wheels over the edge of the cliff. Make it therefore a golden rule: never leave your car, whether the engine is running or not, without first putting the speed lever in the out-of-gear position and also putting the side brakes on.

It sometimes happens that, although all the operations set out above have been performed, the engine does not respond to the turning of the handle. Under these circumstances, it is well just to jump the float needle up and down once or twice, to make certain that a little petrol has gone into the carburetter. It may seem rather unnecessary to have to recapitulate all these minor points, but it has often occurred that even experienced drivers have tried for quite a long time to start their car without the electric current being turned on, and in some cases have started their car, and driven a few yards, when

the engine has unaccountably stopped, and after some searching they have found that the petrol was not turned on.

The troubles in regard to the starting, &c. of the engine are dealt with in the chapter on the Petrol Motor.

Lubrication.—Although perhaps this subject is hardly one which should be dealt with in this chapter, it is of such great importance to ensure the successful running of the car that it cannot be dwelt upon too much. Lubrication above all things spells life to the motor-car, and the lack of it must result sooner or later in disaster. Therefore see before starting for a drive that all the bearings of the car are properly lubricated, and also be sure during the drive that the lubricator to the engine is working satisfactorily.

After having been for a drive or having the engine running, the next thing to do is to go through another set of regular functions which should always take place before putting the car away. Turn off switch to electric current, turn off main petrol to carburetter, turn off lubricators, and then have the engine turned smartly by hand and a little paraffin pumped into the cylinders from the pump provided for this purpose. This is to ensure that the piston rings shall not become gummy or sticky, and it is a great point in assisting the engine to start easily next time. It is as well, too, to feel the wheel and other bearings to make sure they have not heated.

Driving Backwards.—After having conquered all the initial difficulties in regard to steering, changing speed, application of brakes, &c., it would be well for the novice to start learning to steer and drive the car with the speed lever in the reverse.

There are comparatively few men who can drive backwards safely and well, but the importance of being able to do this must be very apparent. When driving in traffic it is a very common thing for the vehicle in front to back, and in this event it must be the work of a moment to slip the speed lever into the reverse notch and run back out of danger. To turn in a narrow road where the reverse is required also calls for some knowledge of handling the car when running backwards,

and in the event of the car running backwards when ascending a steep hill the vital importance of being able to steer it safely is obvious. The new Motor Act does not encourage practice in driving a car backwards but skill in this direction is always desirable. It is often impossible to get out of a hotel yard without driving backwards, and it is far from dignified to have to push a car out because one dare not try to drive backwards.

The novice should practise on some quiet wide country road until he attains sufficient proficiency to drive the car backwards at the rate of at least eight or nine miles an hour.

Test your Brakes.—Every wise chauffeur takes the precaution of testing his brakes immediately he starts driving. During a stop something may happen to the brakes so as to make them quite ineffective, or a portion of the brake mechanism may have broken. The driver who perhaps before luncheon has ascertained that his brakes are acting perfectly, after luncheon may start off in the same supposition, and perhaps not discover his error until, relying on his pedal brake to stop him in traffic, he finds that it has no effect, with the result that he probably goes through the back of a brougham.

The Sprag.—This is an adjunct fitted to most cars. In the early stages of driving, it is as well always to leave this down when ascending steep hills, so that in the event of the novice missing his change of speed, or if through any other cause the car tried to run backwards, it would be arrested in its early movement and damage obviated.

It should be borne in mind, however, that the sprag should be dropped before the car actually starts to run backwards; otherwise the momentum on the car may induce it to jump the sprag to the danger of the passengers and the great annoyance of the chauffeur, who finds that before being able to proceed he will have either to detach the sprag or cut it away. We remember seeing the owner of a large motor carriage in this predicament. After taking the precaution of having a solid sprag fitted, he spent some hours beneath his

HOW TO TAKE A CORNER

car in an endeavour to cut through a solid inch and a half of iron with a very blunt hack saw.

Immediately the necessity for the use of the sprag has disappeared, it is as well to pull it up at once by the cord.

Going round Corners.—Always keep to your right side, remembering that in all probability you will find some other vehicle coming towards you from the opposite direction. It will generally be found that as the road slopes towards the gutter, the outside wheels of the carriage will be higher than the inside. The illustration shows how, when encountering a bend or corner the view round which is not interrupted by hedges or other obstacles, a driver—being certain that there are no other persons or vehicles beyond the corner—may take advantage of the banking of the road, and avoid great deviation from the straight course, by cutting across to his wrong side, and hugging close to the angle of the corner.

This is a practice which is adopted when travelling at high speed, as in races, but, of course, should never be attempted on the road, *unless it can be clearly seen that the track beyond the bend is absolutely free from vehicles or passengers* ; otherwise, with the growing use of automobiles, serious collisions would ensue.

Descending Steep Hills.—When travelling down steep hills it is very easy to be deceived, as the nature of the district may make the gradients look very much less than they really are. A very striking example of this occurred in the Thousand Miles Trial of the Automobile Club, 1900, when the Hon. C. S. Rolls, in driving from the 'Cat and Fiddle,' was evidently so deceived by both the gradient and the corner that he actually threw his mechanic off the car, owing to the vehicle travelling at much higher rate than was allowed for, and the gradient keeping the car running at a great speed right up to the corner. The present writer himself, who was just behind Mr. Rolls at the moment, to a certain extent met with the same difficulty.

Using the Brakes.—A very good rule to follow is that under ordinary circumstances the brakes should not be used with

such violence as to cause the wheels to skid, or to occasion a jar to those driving in the carriage. If this be carefully observed the vehicle will last much longer.

We are aware that it is the habit of some drivers to do what is known as 'drive on their brakes'—that is to say, rush up to an obstacle at full speed and then rely upon their brakes to prevent them from dashing into it. However brilliant it may appear to the uninitiated, the practice cannot be too strongly condemned; for not only does an exhibition of this sort try the nerves of the passengers on the car—however seasoned they may be—but it also produces a bad impression on the public, who, not appreciating the control the driver has over his vehicle, marvels at his apparently narrow escape. This sort of thing comes under the heading of inconsiderate driving, and is not only unnecessary but at the same time bad form. The danger of the practice is also very great. It will be remembered that a very serious accident occurred some time ago on a hill near Harrow through this very cause. The unfortunate driver, who was killed, was one who was well known to rely on his brakes to an extraordinary extent, driving full speed up to his stopping point and then applying the brakes with very full force and stopping in the shortest possible space of time. In the early days of the sport this was thought by some to be a sign of good and skilful driving, but experience has taught us that the best driver is the careful driver who takes no unnecessary risks.

The sudden application of the brakes and the consequent locking of the wheels is to be commended from a pneumatic tyre manufacturer's point of view, but from no other.

Dangers of the Road.—Some of the greatest dangers to be met with on the road arise from other people, not because they are there, but because of their indecision; and in the forefront must be put people alighting from tramcars, or children holding on to the backs of carts and trams. They suddenly hear the motor approaching, and although their safest plan is to remain where they are, they make wild dives in any and every

direction, with the result that, unless one has the car completely under control and ready to stop at a moment's notice, a bad accident may happen. It is a good rule when meeting with undecided wayfarers to make up one's mind the way one wants to go and continue in that direction; at the same time keep your brakes well in hand, so that if necessary you can pull up dead and avoid striking them.

Lady cyclists were formerly a great danger, as they were apt, when a motor was heard approaching them from behind, to fall off their machines, apparently in terror; but this distressing spectacle is now comparatively seldom seen.

A swerving horse which swings round at the last moment is another danger to be guarded against, and on approaching any horse it is always well to assume—as is too often the case—that it is not under the control of the person driving it; either he is intent on looking at the motor, or very likely he cannot drive. It is advisable to slow down to the pace at which the car can be pulled up immediately a horse shows signs of wanting to monopolise the whole of the road. This danger is very much increased if the horse is attached to a cart with a long piece of timber projecting at the back, as a very small movement of the animal may completely block the road. One or two very bad accidents have occurred thus.

In driving at high speeds avoid trying to look behind. A Belgian nobleman was once killed owing to taking a glance behind him when driving a racing car. He apparently deflected his steering wheel a little, with the consequence that before he turned his head again the car had dashed into the bank by the roadside. The barbaric system of carrying small water drains in shallow trenches (known in France as *caniveaux*) across the surface of the road has been the cause of many accidents. They may be found in many French villages and on some English roads. They are difficult to detect, but a good driver should always have an eye for the road and be prepared to slow down to a walking speed in passing over these trenches. The same remarks apply to badly made level crossings of railways.

Some of these are disgracefully constructed. That at Colnbrook, on the Bath road, is an example of how they should be designed: that at Mortlake station of how they should not. Where the road crosses small streams the bridge is sometimes made in the shape of a sudden hump (the French call them donkeys' backs) instead of a gradual and nicely curved ascent and descent. These must not be attempted at high speeds. To drive fast over a trench, a bad railway crossing, or a bad hump, may result in broken springs, bent axles, and strained frames. The novice should bear in mind that cars are not designed for steeplechasing, and a broken horn of the front springs leads to the displacement of the steering gear, and possibly a sudden swoop across the road, into a wall, a ditch or—Eternity.

Side-slip.—We now come to another danger or difficulty, and that is side-slip—the bugbear of the expert as well as of the novice. Under certain conditions all roads in towns become exceedingly greasy and slippery to a rubber tyre, so much so that if the brakes are applied the carriage, instead of stopping, merely travels on with the wheels locked, and on greasy asphalte will go almost as far in this fashion as with the wheels revolving. Drivers are, however, never likely to meet with accidents from side-slip if they will only drive cautiously. In town, if one keeps in the ordinary line of traffic, and proceeds at the same pace as the other vehicles, the result should be perfect safety, for one can always stop as quickly as the ordinary 'bus in London, even under the worst conditions. There is simply no royal road to get over this difficulty except driving cautiously, and driving at such a speed that it is only necessary to apply the brake in a very gentle form. If one drives at greater speed than this, accidents are bound to happen, and no one but the driver is to blame.

In regard to the different types of greasy roads, asphalte is probably the worst, though greasy wood, and chalk or oolite road, are almost as bad. Perhaps the chalk road is the most dangerous, as one comes upon it out in the country when pos-

A SIDE-SLIP

sibly travelling at a high rate of speed. Greasy tram lines are also exceedingly bad, but as the car should be travelling slowly when these are encountered, accidents ought not to happen if proper care be used.

In passing over tram-lines they should be taken at a good angle, for if the crossing be cut too fine the wheels may drop into the lines and a slip result. Greasy macadam is bad if high speeds are attempted, but up to ten or twelve miles an hour there is seldom any difficulty in 'negotiating' it. Ice is the worst of all, but this condition occurs very seldom, and of course no attempt should be made to travel at any great speed over it. An account, however, of a drive under these circumstances was given by Mr. Mayhew in an issue of the Automobile Club's 'Notes and Notices' some time ago, and being of interest it is quoted.

After descending Aston Hill, and when within five miles of Oxford, he struck a strip of road which was solid ice, but which, owing to the thaw that had started, was running with water.

Awful side-slip, hit side of road left, right, left, after which went straight again. One mile from Witney he noticed a sharp descent with a similarly treacherous surface. He had not time to pull up the car, so put the brakes on at the top of the hill, which stopped the driving wheels dead, while the car calmly glissaded to the bottom. When he got to the bottom he put in the clutch on the second speed, and essayed to run up the other side, but as soon as the momentum had fallen, the driving wheels began to slip, then the first speed was dropped in, but the car eventually stopped with the wheels revolving on the ice. Then, with the power still on, it slowly slid to the bottom of the valley backward. However, by getting some strips of sacking which he tied round the tyres, the summit was gained. It is suggested that the partial deflation of the back tyres might have helped Mr. Mayhew. Of course, the conditions were so exceptional that no provision is usually made for them. If they were common, it would certainly be necessary to have a sand box; in fact, an adaptation of the railway steam sand blast, but worked from the exhaust, would be necessary!

When driving on greasy roads it is always well to keep as far away as possible from any vehicle in front, whether it be a motor-car, a horse-drawn vehicle, or a cycle, as this allows plenty of time to pull up slowly and gradually.

In regard to the various accidents which may happen to the car itself through outside causes, one thing to be remembered is that the fly-wheel or front axle of the car is probably not more than seven or eight inches above the ground; therefore if very rutty roads are being used, it is well to direct the wheels out of the cart ruts and keep one rut in the centre of the vehicle. It is also well to keep a good look-out when entering park gates or stable yards where high centre stones are often placed, for if anything is struck by the fly-wheel it is almost certain to break or bend the crank-shaft of the engine, and a costly repair is necessitated.

A Punctured Tyre.—There is another little difficulty in regard to steering, and that is if a front-wheel tyre bursts or punctures, that side of the car is immediately somewhat lower, and owing to the tyre being flat, it exerts a severe retarding tendency to that side of the vehicle, with the result that if the right-hand tyre punctures, it tries hard to run to the right. This must be resisted and the car kept firmly on its course, the brakes being applied gently but firmly, and the car pulled up as quickly as possible without a sudden jerk. To give one some idea in an exaggerated form of the power exerted by a deflated tyre we will give a personal experience. When travelling on a big racing carriage over seventy miles per hour, the front tyre was cut by a broken piece of bottle, and in a second the tyre burst. The whole tyre and tube were torn off the wheel by the centrifugal force exercised and the car was running on the iron rim. In holding the steering straight against this tremendous pull, the steering-wheel steel shaft was twisted a quarter of a turn. Of course, if the car had been allowed to deflect for one moment from a straight line at this speed, a most frightful accident would have followed.

Night-driving.—When driving at night one should never travel at a speed greater than that which affords time to pull up after seeing any object clearly by the light of your lamps. Of course if two acetylene lamps are used one can travel up to twenty-five miles an hour in perfect safety, the road being sufficiently illuminated to give plenty of time to stop; but if ordinary oil or candle lamps are used, eight or ten miles is the limit of safety. In very foggy weather it is best to turn one lamp sideways so as to indicate the side of the road. The off-side lamp pointing forward should be covered with a handkerchief, to diffuse the light and cause less refraction from the fog in front.

One of the most difficult things to see on the road at night are sheep, as they make little noise when going along slowly, and seem to blend with the colour of the path. The writer remembers some years ago running into a flock of sheep from this cause when travelling late at night on a carriage having only candle lamps. The consequent smash and the amount of attendant repair bill are still engraven on his mind.

It must also be remembered that many people walking, seeing the lights of the car, assume that you see them as well as they see you. Again, it is almost impossible to believe, until one has had actual experience, how invisible some large objects are which may be on the road in front of you at night, and which it is impossible to see until one is within a few yards of them. In summer, probably owing to the roads being usually white, the light from one's lamp is much more effective than in winter. A very dark night is actually better for driving than a moonlight night with the moon partly obscured by clouds.

In conclusion, it is well to remember that under all circumstances a fixed habit of careful driving should be practised. Reckless driving has no utility, and must result in a serious accident sooner or later. The difference in the time taken by a careful driver and by a reckless driver in a day's journey is infinitesimal. To obtain this small gain, however, the reckless driver has probably incurred a tremendous number of risks all

totally unnecessary, and caused considerable annoyance to everyone else on the road.

Probably the chief offenders in this respect are the paid *mécaniciens* or drivers for companies or private owners. Having no responsibility, no care, no consequences to face—beyond the possible loss of the weekly wage—infinite damage can be done by a man of this type dashing through villages and crowded thoroughfares. Therefore impress the fact on your mechanic that your car is to be driven as considerately when you are off as when you are on it, and if your instructions are not carried out, cure the complaint by dismissing the man.

Grievances in regard to the speed of motor-cars would have had no ground if every driver took upon himself the obligation of gentlemanly conduct on the road, acknowledging that the highway is public and that a large number of other persons have equal rights to its use. Therefore slacken your speed in any and every place where you think that some other user of the highway may be inconvenienced by your passage.

CHAPTER XVI

THE CHARMS OF DRIVING IN MOTORS

By the Rt. Hon. Sir Francis Jeune, K.C.B.

This is an old country, and one of our most valuable pieces of inheritance is the ancient asset of good roads penetrating every corner of the island. New countries may have fine railways, but though, and perhaps because, they have fine railways they have not, and never will have, roads equal to ours. And it is not only an ancient, it is also a well-preserved asset. It is the duty of any one who uses the roads of Great Britain for motor-cars to express his gratitude perhaps to the ancient Romans, certainly to the old turnpike trustees and to their modern successors the county councils, and I say this the more emphatically in the hope of encouraging the county councils to persevere in their good work. These roads are the sphere of the motor-car, and my belief is that, could we consult our friends the horses, there would be whatever in the case of horses corresponds to a plebiscite in favour of utilising it to the fullest extent.

Many persons did, and, I am afraid, some persons do still, accuse us of a love of too rapid progression. I feel inclined myself to plead guilty to the limited extent of acknowledging that there is a glorious exhilaration in the mere motion of a motor-car, strong, unwearying, unresting, with no drawback of regret for strain of exertion on man or beast. The mere sense of motion is a delightful thing ; the gallop of a horse over elastic turf, the rush of a bicycle down-hill with a suspicion of favouring wind, the rhythmical swing of an eight-oar, the trampling progress of a four-in-hand, the striding swoop on skates

across the frozen fens—all these are things of which the reminiscence and the echo come back to us with the dash and pulsations of the motor-car. Even Dr. Johnson thought that nothing was so delightful as the rapid motion of the post-chaise. I should like to have given the sage a lift in a motor-car, and gained for the world the testimony to a sensation of delight by a philosopher theretofore undreamt of in his philosophy.

And in this pleasure of motion we are, if not independent of the weather, at least almost independent of seasons. The hotter the sun the more agreeable the fanning of the air through which we pass, and the cold of winter, guarded against in proper fashion, carries with it its own exhilaration. To my mind the greatest pleasures and the greatest advantages derivable from the motor-car are the power of traversing large areas of the beautiful country in which it is our happiness to live. The use of motors in town is increasing and, doubtless, will greatly increase. It is no small advantage to be able to go from place to place with no thought of tiring horses and no fear of cold through waiting. But even to those living in towns, the country contributes most to the pleasure of possessing a motor. At one of the dinners of the Automobile Club, when it was suggested that motors had a future in bringing agricultural produce to the large towns, the audience agreed with the observation that, if it was desirable that the motor should bring cabbages to the workman, it was still more desirable for the motor to take the workman to the cabbages. For myself, after a long day in Court, I often feel that I am a workman who wants to be taken to the cabbages. I remember hearing it said that, in his last illness, Lord Beaconsfield derived great pleasure and benefit from driving in the lanes of the north of London, amid surroundings of the rural character of which, so near London, he had hitherto little idea. Where are those lanes now after an interval of only twenty years? The ring of suburban habitations grows constantly deeper and denser, and it is, I think, an invaluable

function of the motor-car that for many years to come it can, even in an idle hour or two, carry us from the heart of the metropolis into the woods and fields of genuine country. It is a case of civilisation providing an antidote for its own poison, and I for one am glad to be able to enjoy both the poison and the remedy.

The country is, however, and I think it always will be, the best sphere of the motor. I am afraid I cannot help recurring to my personal experience, but judging from that, a motor justifies its existence best from the great, the never-ending, the ever-changing delight of travelling through many miles of country surroundings.

To many of us come all the pleasures and excitement of exploration. I am sure most persons know of a corner of their counties, previously as inaccessible as the North Pole, which can now be visited with no fear of a chill welcome at the end, and with the prospect of the consumption of something better than the train oil of the Esquimaux *gourmet*. If we live near a range of hills there is the perpetual curiosity as to what is to be seen on the other side. I believe that the Duke of Wellington used to say that the best general was the man who knew what was on the other side of a hill. We are all of us in that sense qualifying to be generals now, with the difference that the knowledge we gain is that of friends and not of enemies. Even if the country through which we pass is familiar, there is not only the pleasure of seeing it under the different aspects of weather and season, but there is the interest of observing the behaviour of our faithful car, as it traverses distances and mounts hills, of the difficulties of which we are often possibly only too well cognisant. And there are not many districts, I should suppose, which have not at least one hill to excite the aspiration of unsatisfied ambition.

But we clip the wings of the possibilities of motors if we limit them to travels of which a home is the immediate centre. The trials organised by the Automobile Club point to the practicability of journeys for which our country is so admirably adapted.

The motor-car may become a land yacht with more variety of scenery than its marine prototype, and an absence of the frequently disconcerting motion peculiar to the sea. I do not at all depreciate the pleasure of travelling over a beautiful country in a railway. No one who has looked down from the Brenner Pass into Italy, no one who has climbed up the spiral line to Andermatt, or who has speeded over the sunny plains of France or even the expanses of Russia, at least in the luxury Russian railway-carriages afford, will doubt that railways can give an adequate experience of scenery of a grand and far-reaching character. But what do they know of England who only England know from the window of a railway-carriage?—the great plain or valley, even with its sunlit varieties of grass and corn and wood, contributes only a small part of the beauty which England has to show, but which she declines to disclose to the railway-traveller.

The voyager by road thinks less of a great expanse of scenery, bounded though it may be by the long waving line of mysterious hills, than he does of the thousand sights of beauty and interest under his eyes. A railway has no foreground, unless telegraph posts on an embankment half-clothed, and not at all ashamed, can be said to constitute such a feature. To a road and the traveller on it the foreground is everything. The hedges, the trees dappling the road with shade and sunshine, the cottages, the village greens and ponds, the village itself through which we pass with a fleeting interest in its life, the glimpses down side lanes into their infinite suggestions of light and colour—these are sights repeated in the endless variety of nature and rural life, and of which the changeful pleasure is unending. I am not sure whether the motor-car is as popular in the rural districts as it is, or at least I believe was, in France, but I fancy that to-day, if we choose, we shall not find our neighbour anything but cordial. We revive in these later days very much of the spirit of the old coaches, and we may perhaps revive something of the interest in them of the country inns and the people of the country. Speaking again

for myself, I have never found the country people anything but kindly and interested, and indeed quite ready to enjoy the new experience. I remember once somewhere in Somersetshire a herd of most leisurely beasts slowly preceding us on their way to market, entirely declining to make room for us to pass, as is their fashion, and followed by their herdsman. Gradually the procession assumed the form of the beasts travelling at a somewhat, though not much, accelerated speed, the car close behind and the herdsman panting in the rear, till with a complete appreciation of the situation, he hurried up to say, 'Seems to me, measter, if you be going to drive them beasts all the way to market you had better take me up.' The market fortunately was not far distant, but I think the herdsman would not have objected to a similar ride as each market day came round.

The old people seem to manifest more curiosity than the young. The school children, it is true, usually line the road and utter shouts of which I have never been able to discern the significance, or seek the delight, to me, I confess, wholly unintelligible, of throwing their caps under the advancing car. But when a car stops old people invariably surround it with criticism and inquiry. The witticism, 'Seems to me, measter, your horse can't get on without drinking any more than ourn,' never fails, and many an old lady gladly accepts the experience of a ride to the end of her village and back again. I wish I could add that horses in the country manifested more indifference than their owners. But I am afraid it is just the old agricultural horse, who looks wise enough to know better, that exhibits an unexpected excitement, unless indeed he is standing unlooked after by his master, in which case his indifference to the passing car is usually beyond all praise.

We have in the motor-car of the good type to-day a new and growing source of health, of pleasure and advantage, and we, who have been the first to avail ourselves of it, may without undue exaltation congratulate ourselves on our wisdom and those who follow us on our example.

CHAPTER XVII

ROADS

BY J. ST. LOE STRACHEY

THE RETURN TO THE ROAD[1]

I

DURING the past five years the world has been brought face to face with the fact that carriages can be built which will travel along the roads with safety and comfort, carrying comparatively heavy loads, at a rate of speed which, if it does not rival that of an express train, is sufficient to make the way without rails quite capable of giving us all we want in the matter of fast short-distance transport. This fact makes it certain that the road is once more destined to play a great part in our national life. Already men of all kinds are beginning to talk about the roads, to ask as to the state of the roads, and to inquire into such questions as gradients, surface, width, straightness. When ordinary men travelled by the railway only and merely used a little section of road, hardly more than five or six miles long, to get to the nearest station, the road played a very small part in their lives. Now that travelling along fifty, or even a hundred miles of road is becoming common, and that the return to the road is almost accomplished, the old interest in the highway is, as I have said, reviving, and men are once again beginning to see the importance of the road.

[1] In this chapter I have resumed portions of articles dealing with our roads written by me in *The Spectator*.

PAST AND PRESENT

II

Of course the road never really lost its national importance. It was only that the quickness of railway travelling and the slowness of horse-transport made the road suffer a temporary eclipse—though while it lasted of a very complete kind. The old lawyers declared that title deeds were 'the nerves and sinews of the land.' In a very much more striking and real way the roads are 'the nerves and sinews of the land.' It is they that bind village to village, and town to town, and thread the centres of population as beads are threaded on a string. A moment's reflection will show the vast importance of the part that has been, and must always be, played by roads in our national life. Though the country is covered by a network of railways, we do not, unless we are station-masters, live on the railways. The road is, as it were, the first wife of the nation, and though some sixty years ago the husband took a new wife home, he never discarded the first, and she has in reality always remained nearest to him, and has always held his home. Nothing can take that away from her. We live on the roads, and they are part and parcel of our daily lives. We look down the road for the home-comer, or the new-comer. Our gates open on the road. The road is always with us. The motor-car and the bicycle have restored to us a full remembrance of the fact. While railway travelling was so immeasurably quicker and easier than road travelling, we were forced to give up the pleasure our fathers had taken in the road, for mankind in general cannot or will not lose time. Now, however, the road has been revived. To go back to the marital and polygamous metaphor, just employed, the motor-car has given the road a crown of price that has once again made her find favour in the eyes of her lord and master. The second wife has come to look old-fashioned and dull, and the first wife, never really rejected, renews her claims. No one can deny that from the point of view of beauty this

return to the road is a gain. We only know England when we know her roads. The English roads are like wood-fringed rivers that run twisting and turning through our villages and towns. No one can travel down fifty miles of an English road without coming upon a hundred beautiful and unexpected things, and seeing those things in the best possible way and as they ought to be seen. When we see scenery from the railways, or, at any rate, the near-at-hand scenery, we are, as it were, looking at the brocade of the landscape on the wrong side. We see the pattern awry and upside down. We cut across the roads, not wind down them. We see the old church or the old manor-house not in a picture composed by centuries of usage and of kindly human courtesies. Things as seen from the railway are for the most part set on wrong, face the wrong way, and as it were 'grate on the sensitive ear with a slightly mercantile accent.' The coalshed or the chimney of the heating apparatus is turned towards us in the train, and not the best line of gables or the old lych gate.

III

Perhaps it will be said that all these prophecies as to a return to the road are of very doubtful value, that the motor-car can never really beat the railway, and that as soon as the present fad has passed away, the railway will return to its old ascendency. I do not agree. The autocars will not, of course, rival or destroy the railways. The present railways will always continue to do the heavy and long-distance traffic of the country, while fast mono-rail electric railways will carry the express passenger traffic. Rather the motor-car will feed and immensely increase the demand for express trains and long-distance journeys. The motor-car will not so much injure the railway as call a new kind of traveller into existence. Cross-journey traffic with its many changes, suburban traffic, and short-distance traffic may suffer, but it will be amply compensated for by a great increase in the demand for long-

distance tickets. The fact that will assert itself directly we have a proper supply of easy, quick, and comfortable motor-cars available, is the fact just named—i.e. *that we live on roads and do not live on railways.* The circumstance that a motor-car can stop at the garden gate if we live by a highway, or drive up the carriage-drive and draw up level with the porch if we live within lodge-gates, and take a man direct to the door of his office, or of his friend, or wherever he wants to go to, is bound to make the motor-car beat the train for all short-distance work. Let us take a concrete example. A British householder living in the middle of Kent—say thirty miles from the coast—is going to take his family to the seaside for the usual three weeks. At present the procedure is as follows: When the boxes are corded and the children and nurses 'collected,' they are packed into carriages or an omnibus and taken to the local station on a branch line. There the party and its impedimenta are put into the railway for twenty minutes or so—i.e. till they reach the main-line station. Here the babies and the bicycles are taken out, and after a wait of perhaps half an hour are repacked into the main-line train which carries the party to Bathington West. Here there is another breaking of bulk and temper, and the family is got into cabs and omnibuses and driven to the hotel or lodgings. To accomplish this journey there have been no less than three gettings in and out. If, however, it were possible for the householder to engage a light motor-car for himself and his wife and eldest daughter, a motor-brake for the children and servants, and a light steam-van for the luggage, bicycles, buckets and spades, and perambulators, which would load up, not against time, but quietly at the front and back doors, and unload at the hotel or lodgings, what a vast deal of fuss and worry would be saved! Even if the journey, conducted at twelve miles an hour, took two hours and a half, it would hardly be so long as the time required for (1) driving two miles to the local station, say twenty minutes; (2) getting tickets and arranging luggage, &c., fifteen minutes; (3) going in local train to Buffling Junction, say twenty

minutes; (4) waiting at Buffling Junction to catch express, thirty-five minutes; (5) going from Buffling Junction to Bathington in express, thirty-five minutes; (6) getting out luggage, &c., at Bathington, twenty minutes; (7) losing time owing to late trains—say, twenty minutes in all. That is two hours and forty-five minutes—and who can say that I have exaggerated the delays and friction incident to an ordinary sea-side journey?

IV

But if, as I firmly believe, the roads are going to come back to their old importance, certain facts will at once become apparent. Directly we use the roads for personal and rapid transport mankind in general will begin to find out what the bicyclists found out long ago—namely, that our roads are very ill-fitted for the purposes for which they are designed. To begin with, they are usually too narrow. Next, they are rough in surface, and on the hills very badly 'graded.' Lastly, in certain cases, although this would not often be necessary, a mile or two might be saved by a short cut. I do not propose, of course, that all these improvements should be made at once—and most assuredly all the improvements must be made with a due preservation of the beauty and charm of our country roads and the districts they traverse—but, no doubt, as soon as the importance of the roads, so long overshadowed by the railways, revives there will be a great and pressing cry for highway improvements. It must not be supposed that in urging the improvement of the roads I am thinking merely of the convenience of the drivers of motor-cars. I believe that the improvement of the roads and their restoration and revival would be of the greatest possible national benefit. We all deplore, and rightly deplore, the decay of the village, but nothing would so quickly and soundly help the village as the resurrection of the road. If the men of the villages within the ten-mile radius of London could jump into a motor omnibus or brake and be carried to London for a penny, as they could be, we

should have greatly helped to solve the housing problem. The simplicity of arrangement by which a man in the village could enter the omnibus at his own door and be carried straight to his work would greatly facilitate living in the country and working in town. But if this is to happen, as happen it ought, we shall at once have to deal with the disagreeable fact that London and most of our great towns are exceedingly difficult to approach by road. Almost all the high roads out of London run through a narrow neck, which is perpetually being blocked by traffic. A good example is Hammersmith Broadway. The Hounslow Road on the west and the great Hammersmith Road to the east sides of this Broadway are large and in every way adequate roads, but their size is rendered useless by the narrow half-mile of the much misnamed Broadway. This is not a solitary instance. In a word, if the roads are really to become great arteries of traffic under a system of automobile transport the authorities will have most seriously to consider the approaches to London. London, we hold, ought to be entered by at least eight great roads of uniform breadth, and the narrow necks like Hammersmith Broadway should be entirely abolished. It would be a very costly improvement, but it would be worth accomplishing.

V

It is easy to make out (1) that our roads are going to be vastly more used in the future than in the past, (2) that they have been neglected and cannot carry the increased traffic without great and unnecessary inconvenience being caused to the public, (3) that we ought to improve them. The difficult thing in a complicated political and social community like ours is to suggest how the roads are to be reformed. On the whole I incline to the belief that the plan proposed by the Roads Improvement Association (45 Parliament Street, S.W.) will prove the most practical.

Unfortunately, space does not permit me to state their

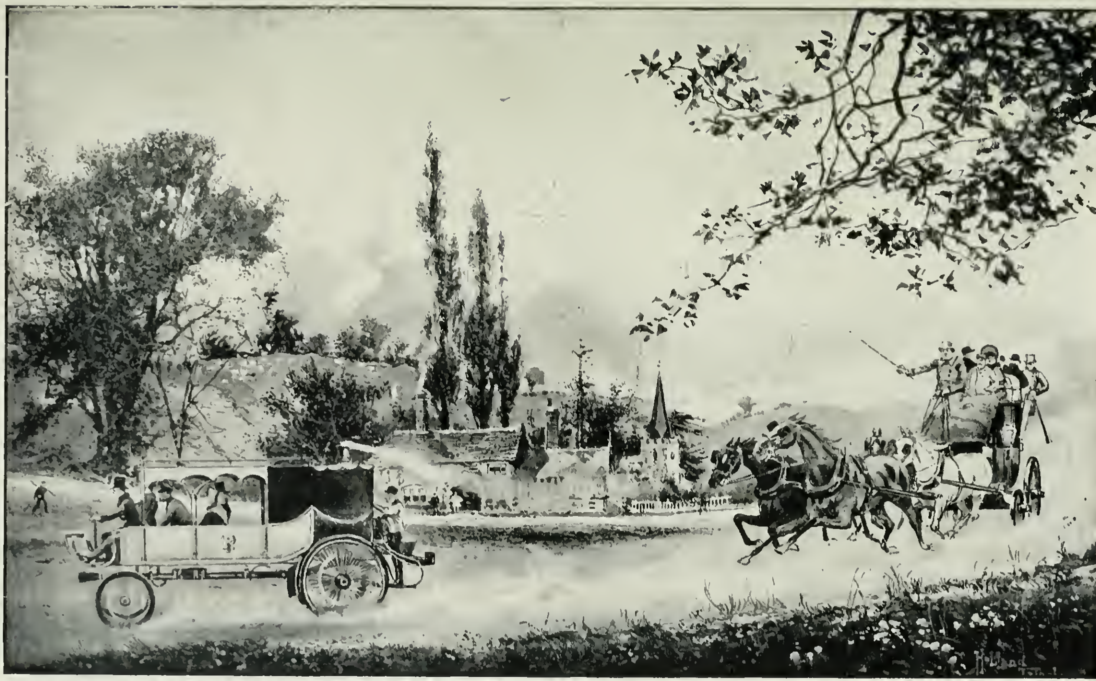
proposals, but I strongly advise all those interested in the subject to send for the documents issued by the Association and study them in detail. They involve radical changes, but are by no means unpractical, and I believe would go far to solve the problem.

But excellent as these proposals are they will of course be of no avail unless public opinion is awakened on the subject. That it will be awakened I cannot doubt, when motor-cars become cheaper, when the prejudice against them has died out completely, and when men find, as they soon will, that it is more economical to keep a motor-car, not only than a carriage and pair, but than a horse and trap.

VI

I have already mentioned how an improvement in the roads and the use of self-propelled carriages and carts will have a centrifugal effect on our great cities, and act as a very important factor in putting a stop to the increase in that urban congestion which has marked the last few years. This will of course be a great national benefit, but the dispersal of the town population will be by no means the only gain. Better roads and cheap and fast traction along them should help, and I believe will help, in the creation of a large number of small proprietors and small tenants—a change which all rural reformers desire. The small farmer, whether owner or occupier, will find it easier to get a living if and when the roads are good and easy of use. Competent observers of French life declare that the splendidly made and well-kept roads of France have greatly helped to keep the French peasant on the soil. For example, the Commercial Agent of the United States at St. Etienne, reporting in 1891 to his Government, wrote as follows :—

> The road system of France has been of far greater value to the country as a means of raising the value of lands and of putting the small peasant proprietors in easy communication with their markets



IN DAYS OF YORE

than have the railways. It is the opinion of well-informed Frenchmen who have made a practical study of economic problems, that the superb roads of France have been one of the most steady and potent contributions to the material development of the marvellous financial elasticity of the country. The far-reaching and splendidly maintained road system has distinctly favoured the success of the small landed proprietors, and in their prosperity, and the ensuing distribution of wealth, lies the key to the secret of the wonderful financial vitality and solid prosperity of the French nation.

I believe this to be no exaggeration. The peasant's difficulty is always in finding ready cash to use in getting his goods to market. But if the roads are really good and do not wear horse and cart unduly, it is wonderful how cheaply a peasant with even the poorest of horses and the shakiest of carts can get his goods to market. If on the other hand the roads are stony and heavy and the gradients difficult, the man who cannot afford to keep good horses and carts and renew them often, is quickly beaten out of the market. Good roads give a very large amount of that fair field and no favour which we all desire for the small agriculturist.

VII

There is one more practical point to which I very strongly desire to draw attention. A great many eager eyes are at the present moment being cast upon the roads by the promoters of electric tramways, light railways and so forth. The keen-sighted business men who conduct these enterprises have already realised what the public has not, that all the world and his wife live on the road, and that the roads are indeed, as I have said, the nerves and sinews of the land. Very naturally then, they are striving to obtain the right to lay their lines along the roads, and so obtain the great profits that arise from place to place traffic. Now I entirely admit that, *prima facie*, there is no objection to these plans. They are, indeed, I believe, in themselves useful, and, carried out under proper conditions, there is no reason why they should not

confer great public benefits while paying good dividends to their shareholders. But we must see to it that proper conditions are observed. And the first and most vital of these is that no company must be allowed to lay any tram or other line along a road unless they agree at their own charges to increase the width of the metalled surface of the road by the width of the largest car which they propose to place on the road—say eight feet. If this condition is not insisted on, we shall see our roads, already far too narrow, seriously reduced. To lay rails and then to run huge cars, often in double lines, as between Kew and Hammersmith, is in effect to produce a most material narrowing of the road. When a road is given over to a tramway company without any increase in its metalled surface, it becomes at once distinctly less valuable for ordinary traffic. By allowing tram-lines to be laid without any corresponding widening of the roads, as has been done hitherto on our suburban roads, we are positively going back, actually making our roads less open to traffic than they were. No doubt it will be said that to demand this increase of the metalled road surface is to lay on the tramways a burden greater than they can bear. I cannot agree. To begin with their prospective profits are very large. Next, the extra expense would not be very serious, because to increase the metalled surface by eight feet could in the case of most of our country main roads be accomplished without buying more land. There is always a strip of land on each side available for widening. To level and metal, and then lay the lines there, would not be very much more costly, and certainly much more convenient to the public, than to tear up the existing road and put the lines there. I venture then to suggest that no local authority should be empowered to give its consent to any scheme for laying lines along its roads unless the company proposing the scheme agreed to widen the metalled surface by the width of its cars. Provision might of course be made for a dispensing power in exceptional and peculiar cases. No one would want to shave off the façade of an Elizabethan

manor on one side or of a Georgian red-brick house on the other in order to comply with the suggestion just made. It can be applied reasonably and yet adequately. The great thing is to apply it and to prevent our roads being narrowed by the tramway companies, who, as we see by the recent applications in Surrey, are intent upon laying their lines in the rural roads within the thirty miles radius of London. The schemes are excellent in themselves, and under proper conditions deserve all encouragement, as tending to disperse the metropolitan population, but care must be taken that roads with tramway lines along them are made wider, and not in effect narrower than before. I note and admit the objection that I am proposing in some cases to hand over the roadside greensward to be metalled. Of course such a loss of pleasant walking ground must be regretted, but it is, it seems to me, a case in which public utility must be the dominant consideration.

CHAPTER XVIII

MOTOR-CARS AND HORSES

BY HERCULES LANGRISHE,
Master of the Kilkenny Fox Hounds

ONE of the chief reasons for the opposition shown to the introduction of motor traffic in this country has been that motor-cars have frightened horses. When bicycles first came in precisely the same thing happened. Everyone, including the writer, who rode the old high bicycle, can well remember the day when it was necessary to dismount continually on account of restive horses, and when cyclists were subject to much abuse from nervous drivers; but to-day it is an exceedingly unusual thing for a horse, or even the rawest unbroken colt, to pay the very slightest attention to a bicycle.

Automobilists find that provided they conduct themselves properly they do not receive discourtesy from the drivers of horses who are thoroughly the masters of their animals. It is the nervous driver, the man who is frightened of his horse and has neither the knowledge nor the courage necessary for its control, who gives vent to his irritation by abusing motorists.

As one who has driven horses in every sort of harness, and has also journeyed many thousands of miles in automobiles, my opinion is that drivers of horses have very often good reason to complain of want of consideration and discourtesy on the part of motor-drivers, and automobilists who drive recklessly and without proper consideration for other users of the road well deserve the wholesome abuse which is frequently given them.

On the other hand, it is only right that the large class of automobile drivers who show every consideration possible for other users of the highway should not be held responsible because a horse misbehaves itself on encountering a motor-car. Horse-owners must recognise that motor-cars have a right on the road, and, provided that the motor-car be driven properly, its owner must not be blamed because a horse objects to it.

The law as it now stands requires a motor-driver to stop when a man in charge of a restive horse holds up his hand. This, in my humble opinion, is very often a great mistake. What usually occurs is this : a person in charge of a nervous horse holds up his hand, and the motor-car is brought to a standstill. This does not inspire the animal with the least confidence, in fact it sometimes appears that an ill-broken brute of a horse regards the motor carriage as a sort of diabolical wild beast crouching to make its final spring and demolish him.

It has been stated that the horse still retains many of the instincts which were possessed by its forefathers in their wild state. It is well known, for instance, that horses will become terrified with fear when passing a menagerie containing lions, tigers, &c., although the cages holding the animals are boarded round so that they cannot be seen. The odour of these beasts of prey terrifies the horse. This clearly is due to heredity. It is maintained that a horse fears any strange object which approaches it, first slowly, and then stops, just as a wild beast would do when about to spring at its victim. Possibly the horse for this reason fears a motor-car which approaches it cautiously and then is stopped in compliance with the demand of the horse-driver.

If all motorists would drive with consideration there would be no necessity for the law which requires them to stop. But as things are, perhaps the provision which gives the driver of a restive horse power to stop the motor-car is indispensable.

Fortunately the horse is quickly educated. As I have before remarked, horses have grown quite used to bicycles,

and dwellers in cities see that horses are becoming, and in most cases have become, absolutely indifferent to the motor-car. The evil therefore is only a temporary one; but in the meantime it is the duty of horse-owners to take steps to have their animals trained to meet motor vehicles without fear; I maintain, too, that as motor vehicles are daily increasing in numbers, owners of high-couraged horses that are known to become absolutely unmanageable should take special care that their animals are never allowed out on the highway in charge of incompetent lads, who, if a motor-car is encountered, are unable to control them.

A horse swerving and backing a cart across the road in a village recently as nearly as possible caused the death of a group of four small children who were playing on the pavement in the village. The back of the cart crashed into the wall of a cottage within a yard of the little group.

There was sound wisdom in the decision given by a court of justice in Paris, where it was held that it is the duty of owners of horses to have them trained to meet motors.

The difficulty which has presented itself has been how horse-owners may obtain opportunities of training their horses to meet motor vehicles. The Automobile Club has already given demonstrations at the Ranelagh and other clubs near London of how horses may best be made tractable, and has advertised these opportunities. If any owner of restive horses will apply to the secretary of the Automobile Club, that gentleman will doubtless be able to arrange that some motorist in the neighbourhood will drive his car to the horse-owner's establishment and there train the restive animals. Members of the Club have done this over and over again, and motorists generally are most anxious to assist in this direction, thus overcoming prejudice.

A well-known nobleman took the precaution to send his horses to Coventry, in order that they might reside in the centre of motordom, and they quickly became used to cars.

The process of training is extremely simple: the horse

ACCUSTOMING HORSES TO MOTORS

should be stood in a paddock and the motor vehicle driven round it in gradually decreasing circles. The driver of the motor should then talk soothingly to the horse, and the groom should also encourage it as much as possible. The horse will follow with his eyes the movements of the car, and, as a rule, in a little while will allow it to be driven close by without any further signs of fear. The horse should then be harnessed and taken out on the road, the motor-car driven out to meet it, and sent a number of times past it until the animal takes little or no notice. Such treatment as this will be found to succeed very quickly with the ordinary horse which has been trained for road traffic; but special measures might be necessary in the case of some horses which cannot be cured of shying on passing a piece of newspaper, a drain ventilator, or any unusual object.

As regards the relationship between motor-owners and horse-owners, I fully endorse the admirable letter of the late Sir Henry Thompson which appeared in the 'Times' in 1901, as also the remarks made by Mr. Walter Long, President of the Local Government Board, as follows :—

> The people who use cars ought, I think, to remember that it is not sufficient merely to obey the letter of the law, but that they ought to use their motor-cars as they would use any other portion of their property, no doubt for their own advantage and enjoyment, but also with due regard to the comfort and convenience of the rest of the community.

It may not be out of place for me here to make a few remarks *re* the rule of the road. Everyone knows that on vehicles meeting the law is, Keep to the Left. Now Great Britain and Ireland are the only countries in which, so far as I am aware, this is the rule. In France, Germany, America, &c., vehicles meeting keep to the right, and until I took to driving an automobile I never gave the matter a thought, but now the reason is obvious. Take, for instance, a man leading a stallion or other horse on the public highway. The man in charge of the beast naturally leads the horse on his right-hand side. A

motor-car comes in sight. The animal grows more restive than usual, and the unfortunate man is most likely to find himself in the disagreeable position of being jammed between the road fence and the horse. Many may say 'Why shouldn't this man lead the horse from the other side?' but this would be almost as difficult as writing with one's left hand.

I have read from time to time many articles about Motors and Hunting; some Masters of Hounds and Committees of Hunts go as far, indeed, as to forbid gentlemen to drive to their meets in motor-cars. Now there are arguments on both sides.

If a Master of Hounds intimates that he dislikes motor-cars on hunting days, well and good, then they ought not to appear within reasonable distance of the meet. The M.F.H. may have exceedingly good reason to object to the automobile. Perhaps the neighbouring packs may be in a vein of bad luck, and he may be afraid of having his already too large field increased by the extra facilities of locomotion; or he may get it into his head that in a very short time many people will think the motor an easy, comfortable, and safe way of hunting on wheels, and if that kind of thing were tolerated every fox in the country would be headed and sport would suffer.

If such are his opinions he has a perfect right to them, and no motor ought to be seen within the limits where he by courtesy holds sway. He may be right and he may be wrong, but all must acknowledge that the word of the Master is absolute law within the area in which he is hunting for the time being. He is, in fact, recognised by all the sporting community as absolute monarch of the district for the day, and no one calling himself a sportsman or a gentleman would dispute the fact.

Perhaps my own experience of motoring and hunting may throw a little light on the subject.

I hunt my own hounds four days a week, my distances are very long indeed, and I found in former seasons that after a hard week I had had more than enough of it. In the

summer of 1902 I bought a Panhard car, and told all my supporters that I intended using it exclusively to convey me to the meets during the coming season.

Their consternation was extreme. Some were amused, some horrified at the idea, but I carried out my intention to the very letter, not employing any other means of conveyance to take me to any meet above two miles from my own hall door.

All the hunters got used to the motor almost at once, and now it is no uncommon thing to see five or six cars at a meet of the Kilkenny Hounds. Of course if one observes a farmer on a young horse, or a second horseman leading another animal, one naturally pulls up if the creatures are the least frightened, and allows them to trot on to a gate or turn up a bye-way; but this does not often occur.

To forbid a gentleman to drive to a meet in his automobile for no other reason than 'because he might frighten the horses,' really does seem to me to be simply childish. We surely are not such a lot of old women as to be afraid that we shall fall off if that 'horrid noisy thing' comes near us, and there seems no other cause for the objection.

Happily my own field is not composed of such timorous people, and many of them ride young horses too. I used to keep three fairly fast trotters, now I have none. The anti-motorist may love the horse, I love him too, but on hunting days I do not wish to see him till I arrive at the meet.

CHAPTER XIX

REMINISCENCES

By the Rt. Hon. Sir John H. A. Macdonald, K.C.B.
Lord Justice Clerk of Scotland

I ask to be allowed in making a start to go a little further back in reminiscence than the time of the present development of road traction. In my youth I was fond, as I still am, of horse-driving, and took driving tours in the centre of England and of Scotland, and most delightful they were. But in passing through charming country scenes which never meet the eye of the railway traveller, it was impossible to resist an occasional cloud of melancholy when traversing the magnificent old mail roads, often seeing no living person for miles and miles, and drawing up at grand old country posting inns with great empty yards and ranges of rooms above them with closed shutters; once the scenes of life and cheerfulness, but now reduced to a tap-room and accommodation for a lodger or two. The invasion of the rail had swept the country of its traffic, and the Red Lion and the Blue Boar languished, the boots of the Boar and the chambermaid of the Lion, reconciled by joint misfortune and agreeing for once—as Mr. D'Israeli recounted—in denouncing the 'igominy o' railroads.' Who at that time would have believed that at the end of the century, when the railways were congested with traffic, and the public under the tyranny of oppressive traffic rates, a new mode of locomotion would assert itself, reviving the road once more, not only for touring and social life, but also for the benefit of the farmer and the merchant, cheapening and facilitating road traffic both

in town and country, and again giving the highways their place in ministering to public convenience and enjoyment? Yet this is the practical—the socially and nationally important lesson —which is brought to us by reminiscences of the few years in which the mechanical vehicle has been steadily asserting itself, in the face of unreasoning prejudice and pig-headed obstruction. The keenest opposition has come from the squire, the farmer, and the innkeeper, the very people for whom the development of power traction on the roads is certain to work out almost incalculable good.

It has always been so. Although our reminiscences carry us back but a very few years, we know that the idea of mechanical traction on roads germinated three-quarters of a century ago, and took practical shape both in England and Scotland; of this the Automobile Club possesses abundant proof, both literary and pictorial. And history tells how determined were the efforts of the obstructionists of those days to crush out the power vehicle, the opposition being carried even to the length of piling large stones on the road, or cutting ditches across it, to ruin the enterprise, by wrecking the vehicles, even at risk to human life. These tactics were only too successful, and delayed a great public advance in locomotion for more than half a century.

But before the Act of 1896 was passed there were a few automobile Hampdens, who were prepared to face the terrors of the law in order to bring the new locomotion into public notice, and to show to their fellow-citizens what was before them, if only obsolete statutes could be rolled out of the path of progress. And in these reminiscences they deserve to be the first to speak for themselves. Whether there were others I know not, but three I do know, two in England and one in Scotland. First I cull the following from the Hon. Evelyn Ellis. He relates that he first purchased a 'Panhard' 5 h.-p. two-cylinder car in 1894 for use in France, and when in 1895 Mr. Shaw Lefevre was about to bring in the Light Locomotives Act, but was prevented by the resignation of the Government,

Mr. Ellis resolved to bring his car to England, in the hope that he might be summoned by the police and thus draw public attention to mechanical transit. An account of one of his drives was given by Mr. Frederick R. Simms, the originator of the Automobile Club of Great Britain and Ireland, who accompanied him, from which I make the following extracts :—

It was delightful travelling on that fine summer morning. We were not quite without anxiety as to how the horses we might meet would behave towards their new rival, but they took it very well, and out of 133 horses we passed on the road only two little ponies did not seem to appreciate the innovation. . . .

Going down the steep hill in Windsor, we passed on to Datchet, and we arrived right in front of the entrance hall of Mr. Ellis's house beyond Datchet at 5.40, thus completing our most enjoyable journey of fifty-six miles, the first ever made by a petroleum motor carriage in this country, in 5 hours 32 minutes, exclusive of stoppages. The average speed was 9·84 miles per hour. In every place we passed through we were not unnaturally the objects of a great deal of curiosity. Whole villages turned out to behold, open-mouthed, the new marvel of locomotion. The departure of coaches was delayed to enable their passengers to have a look at our horseless vehicle, while cyclists would stop to gaze enviously at us as we surmounted with ease some long and (to them) tiring hills.

Mr. Ellis continues :—

I then drove from Datchet to Windsor, and from Windsor to Malvern. I was very little troubled by the police, and they were generally satisfied by my producing my ordinary carriage licence. One old stone-breaker threw down his hammer and threw up his arms in amazement as he saw the carriage approaching him, and said, 'Well, I'm blessed if Mother Shipton's prophecy ain't come true! Here comes a carriage without a horse.'

Mr. and Mrs. Koosen's enterprise and determination in the face of difficulties form an example for all. Their reminiscences are so interesting from many points of view that no

'STEADY NOW—IT'S ALL RIGHT!'

excuse need be made for giving them nearly *in extenso*. It is delightful to find that one of the earliest pioneer endeavours was prompted by a lady, and when the reader has seen her account of the early adventures of an autocar I think he will agree that 'The Adventures of a Phaeton' were nothing to them, and that Mrs. Koosen has a right to the description of a good wife, the poet making the husband speak of her as

> Doubling his pleasures and his cares dividing.

Mr. Koosen says :—

Early in 1895, while travelling in Germany, I saw the advertisement of a motor-car builder with an illustration of a car. My wife said she liked the look of the thing, so I ordered one. I had then never seen a motor-car, and was under the impression that you take your seats, press the button, and the machine does the rest. Well, at last, on November 21, 1895, the thing arrived at Portsmouth Town station.

I had been told in a letter from the maker that to start the engine you had to turn the fly-wheel towards you, which I did until darkness overtook me. The only result was a pair of worn-out gloves.

Mr. Koosen here seems to have found the trouble too much for him, for he says, 'And now I think perhaps it would be better to quote my wife's diary (I don't keep one myself).'

November 23.—Took train to Lee and tried to make our motor work ; wouldn't ; came home at five.

November 24.—Awfully cold ; played with our motor—no result.

November 25.—After luncheon saw to our motor, but didn't get it out of shed.

November 26.—Drove to Lee and took Smith and Penning (engineers) ; Penning spent the day on his back without results.

November 30.—Motor *went* with benzoline for first time ; awfully pleased.

December 2.—Waiting for new oil from Bowley & Son.

December 9.—Drove to Lee at 10 ; motor sparked at once and went well. After lunch started for home in motor-car ; came

round by Fareham; had lovely drive; police spotted us; awful crowd followed us at Cosham; had to beat them off with umbrella.

December 10.—Policeman called at 1.30, took our names *re* driving through Fareham without red flag ahead.

December 13.—Went drive round common; tyre came off; sent her to Penning.

December 16.—Took train to Fareham; met Hobbs (Hide and Hobbs, solicitors) and Mr. Heckett, and proceeded to Court House; filthy place; Hobbs spoke up well for motors (see police reports). Silly old magistrate fined us one shilling and costs, 15*s*. 7*d*.

December 27.—Frightened an unattended horse attached to a milk-cart, which bolted and sent the milk-cans flying in all directions.

December 31.—Straps slipped badly, had to get them tightened.

January 4, 1896.—Lost nut off air valve; pushed home.

January 6.—Stuck again, small tube supplying petrol to carburetter choked.

January 14.—Motor got stuck; made noises; sent her to Penning's.

January 19.—Moted to Eastney Lock; Jack got out to hold unattended horses, and I drove the car into the curb and smashed frame. Shoved into a stable close by.

April 14.—Accumulators gave out, humped them into Penning's to get charged.

April 19.—Took fresh accumulators out to Lee, but they would not make the engine go, so took them back again.

April 22.—Took accumulators out again and started at once; did 30 miles for first time in $3\frac{1}{2}$ hours.

April 28.—Heard they wanted motor-cars at the Imperial Institute, so sent our car there.

May 11.—Drove different people about all day in the Imperial Institute.

May 14.—Took Cummins for a drive at Imperial Institute, blew out the asbestos joint of exhaust-box, made frightful explosion noises, and frightened Cummins into fits.

July 18.—By special permission all the cars were allowed to drive to Hurlingham, where we had an excellent lunch and drove round the grounds all the afternoon. On the way back something went wrong with the works, so we took a hansom; car was shoved back to Institute. Awful!

August 21.—Sold our car and ordered another of same make (which we have driven many thousand miles in the last five years).

Who will deny after the reading of Mrs. Koosen's diary that the autocar has given one more conclusive proof of the indomitable character of our race, and of the highest form of human unity, that of husband and wife, being a strength that overcomes all obstacles? Mrs. Koosen will live in history as the first lady of our land to steer an autocar and to have the moral courage to confess that her maiden effort ended in a smash; and Mr. Koosen can pose as the first English martyr of the autocar propaganda, though his suffering consisted only in the extraction from him of one shilling. I do think that if Mr. and Mrs. Koosen's first car can be traced, even though it be to a scrap heap, it should be preserved, and find a place in the museum which must be established for power-traction curiosities.

We had also a pioneer in Scotland, Mr. T. R. B. Elliot, whose reminiscences of his early days of motor-car driving are as follows:—

My experience of motor-cars dates from 1895, for on December 27th of that year I received my first car—a four-seated Paris-built 3½ h.-p. Panhard phaeton.

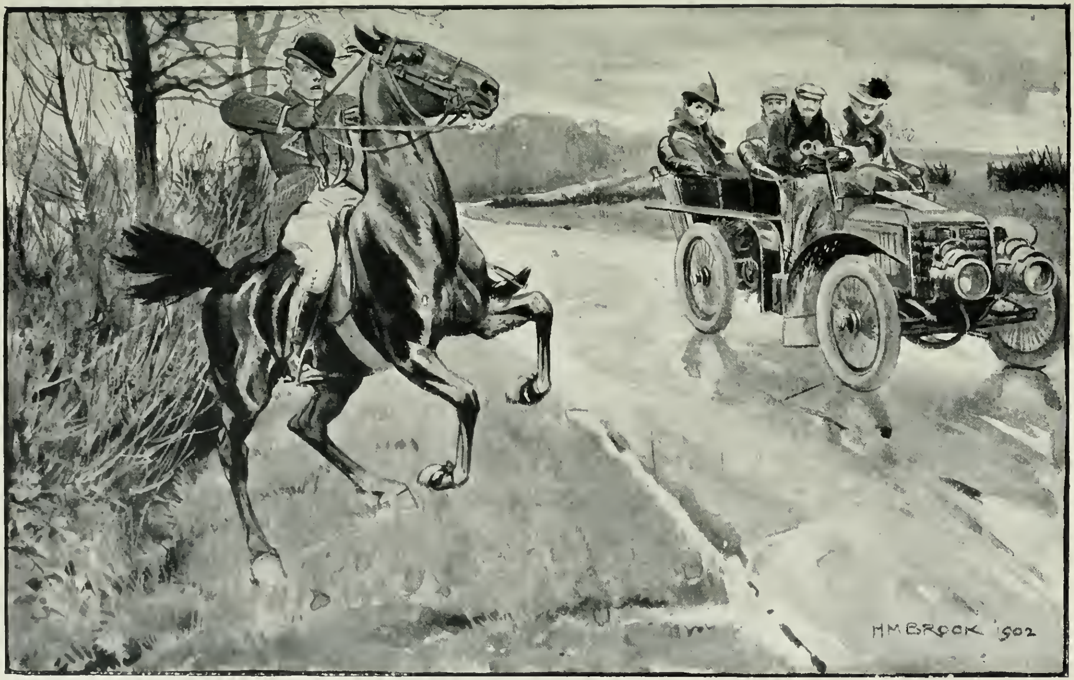
Though I continued to use my car frequently months before the Bill passed, the Roxburghshire police undertook not to prosecute me unless a complaint was received from any of the public. Naturally I drove very carefully, and stopped for almost every horse I met, and was lucky enough to escape any complaint.

However, towards the end of February 1896, I thought I should like to break new ground, so, in order to get a clear road, I started one night at 10.30 P.M. for Berwick-on-Tweed—a distance of 30 miles.

Arriving at Berwick at 3 A.M. I proceeded to picnic under the shadow of the Town Hall, and was there soon surrounded by the entire police force on duty—13 men in all. The sergeant took my name, but did not think that any action against me would be taken. However this was not the case, as I was eventually fined the large sum of 6*d.*, with 19*s.* 6*d.* costs for 'using a horseless carriage without having a man on foot preceding it.'

It is interesting to notice that of my three selected pioneers the only one who was not haled before a judge was the devoted martyr, who hoped, by getting himself convicted, to call attention to the absurdity of the law. Mr. Ellis escaped, while Mr. Koosen and Mr. Elliot were both fined. It is also worthy to be noted that the fines contrast in a marked manner with those of more recent times. One can imagine the consultation on the J.P. Bench. 'There is no need to be hard on these lunatics.' 'Such absurdities as motor-cars will never make their way in this country.' 'The idea of any sane man using such a thing, when he can get a horse, is ridiculous.' 'Oh, fine the idiot 1*s.*,' &c., &c. Now, it is stop-watches, measured miles, policemen in disguise as yokels, 10*l.* and costs—the strongest possible proof of its being realised that automobilism is a permanency which must be reckoned with.

Circumstances did not admit of my being a pioneer myself, but I lay claim to have shown my interest early. I was present at both the Exhibitions, one at the Crystal Palace, and the other at the Imperial Institute, and at an early stage I engaged a seat to go from the club to the Crystal Palace for a competition there. Looking back on these three events now, I feel justified in saying that I have something of the doggedness shown by other pioneers, for anything more disheartening than my experiences it would be difficult to imagine. I took a considerable party down to Sydenham, and found hunting for autocars to be like seeking the proverbial needle in the bottle of hay. At last we found a shed in which were three or four cars and three or four men, machines and mechanics looking equally melancholy and unbusinesslike. After a long wait one car came out and went along the terrace. How it did jingle, and how it did smell, and how it did smoke! My party did not turn and rend me, but when I dilated on the future of this new mode of locomotion, their eyes looked past my head expressionless, and their lips uttered no sound. I could only, on the way back by train, silently chew the cud of discomfiture, hugging the thought in my heart that the day was soon coming when my



'THOSE HORRIBLE MOTORS!'

friends would find that it was quicker to take the road by autocar to reach the Crystal Palace than to rely on the time-tables of any railway professing to carry passengers to that fairy-land at the breakneck time-table speed of eighteen miles an hour.

I was not prepared to face another party of friends, so I went to the Imperial Institute Exhibition alone. Not much encouragement there. A good many carriages on red baize platforms, but so beautiful in paint and varnish that one had an uneasy feeling that they had never known the road, and that no amount of handle labour would bring a grumble of life out of them. One car was going about, which I confess would have had more of my respect had I known that it was the car of the never-giving-in Mr. and Mrs. Koosen. After ten minutes I left the place much in the mood, though not I hope using the language, of Mr. Tittlebat Titmouse when he turned from the railings of the drive in Hyde Park on a certain Sunday afternoon.

These were the days when it was thought practical, as Mr. Butler informs me, 'to turn out a car of one-and-a-half horse-power to carry two passengers, and luggage, spare parts and tools, consequently we had to get out and walk up all the hills, steering by the side, while the engine took the car up by itself; where the hills were very steep we had to help the engine by pushing the car up.' I think, as I am quoting from Mr. Butler, I may conveniently add his general remarks :—

German chains, links stretched and broke very often, and a common thing for a chain to come off; the chains being covered with black lead the hands were always black, and petrol often had to be used to clean them. Tyres German, solid ones, very often came off, and we had to wire them round and round to the wheel the best way we could, to keep them on. Soldering came undone, belts used to break and stretch, nuts came off as there were no pins through the bolts, &c.

Many a time, when miles from an inn and very hungry, would a breakdown occur, but afterwards took precaution never to go out on a car without a large flask of dry sherry and a tin of Bath Oliver biscuits.

I shall here mention an incident which occurred to myself, illustrative of the maxim that in matters sporting you should not prophesy unless you know.

My third adventure, of which I spoke above, was an attempt to realise my prophecy about certain results of a competition in speed between the autocar and the South of London railways on the route to the Crystal Palace. A car engaged for the party came whirling round into Whitehall Court in great style, onto which the secretary, myself and my son, whom I wished to introduce to the joys of automobilism, mounted gaily. We started and rounded into the Embankment, driven by the principal engineer of a company that shall be nameless. A cautious driver evidently, as the pace showed. Too cautious apparently, as a further diminution of pace indicated. 'Give him the w'ip, Gov'ner,' from the delighted cabby. Engineer's face a study. Steers to near side; motion ceases. Crowd gathers; passengers try to look happy. 'Don't 'it 'im, sit on 'is 'ead!' shouts the red-faced 'bus-driver. Passengers desert stranded wreck. End of experience No. 3. Yet, like Mr. Ellis, Mr. and Mrs. Koosen and my compatriot Mr. Elliot, I am as keen as ever.

I have this excellent little story from Mrs. Coleridge Kennard:—

A country parson, without any previous experience, takes it into his head to turn motorist, buys a second-hand Benz Ideal, and calmly states that he intends to be his own mechanician. Imagines cars run without any attention. Is surprised when informed they need petrol, and lubricating oil. Begins operations by fetching a bicycle oiler and giving the piston a niggardly drop of cycle oil. When told this will not answer, is greatly astonished, and expresses his opinion that there is too much oil at one end, too much grease at the other. Has innumerable difficulties, and blames the car for them all. Says his father made chronometers, so he quite thought he should be able to keep a motor in order without much trouble. Finally, after a series of disasters, consults expert opinion, and innocently puts the following query, after complaining that he cannot get his car to go anyhow.

'Oh! by-the-bye, I filled the petrol tank up with water by mistake, I suppose it does not matter?'

Mr. Carr relates the following :—

An enthusiastic friend of the designer of a new motor tricycle eagerly sought an opportunity of personally testing the wonderful machine, which was started and stopped by raising and lowering a back wheel. Off she bounded with a scuffle, and flew round the track. All went well until the E.F. thought he had had enough, when he was seen to be busily engaged with the lever.

As he passed his friends he shouted, 'The lever won't work!' Roars of laughter rent the air. There was nothing for it but to sit it out till the supply tank was exhausted; and this kept our friend fully occupied for the space of an hour and a half. A good non-stop record, no doubt, but apparently more enjoyed by the spectators than by the performer. Report hath it that he had to be assisted home.

Here is a confession by Mr. Sturmey :—

The engine sounded as if pulling all right, but there was manifestly something wrong, so on went the overalls followed by a dive under the car. Suddenly one of the occupants of the car remarked, 'Why, you've got your brake on!' and so I had.

My own most vivid experiences of breakdown, which strongly illustrate the truth that the blame does not often lie with the vehicle but rather with those who turn it out, or who drive it, must be told at the expense of more than one important official of the Automobile Club. The scene on both occasions is the London-Uxbridge road, the driver on both occasions the secretary of the club, assisted on one occasion by the honorary secretary as honorary mechanician. Let me take the last first. Starting hopefully from Whitehall Court we careered along until, just opposite the Wellington statue, the car said 'No further.' Whether it was 'I won't' or 'I can't' we did not know. The imperturbable Johnson said nothing, but with great presence of mind turned round and gravitated to the front of the Wellington Club. All the secretarial skill addressed itself to trace the mischief. Suddenly, the sad word of a penitent

came from the amateur mechanician on the back seat, 'Oh, I forgot to turn on the petrol.' Off again, and no adventure until, on clearing the town, the high speed was put on. Presently off flew the belt, when it was seen that it had been patched many times, and that badly, and being fastened with riveted holders was ill able to stand being joined up again. Another start made, and we approached Uxbridge with joyful anticipations of tea. Alas, just outside the town our engine refused to move. Again the contrite voice of the amateur mechanician behind intimating that he had omitted to turn on two of the lubricating taps. Engine hot, and patience the only cure.

My second experience was in the same car. I started for Gloucester with the secretary for the County Council demonstration. In answer to my question the assurance was given that the firm which provided the car had solemnly vouched that all spare parts were there except those necessary to rebuild the whole carriage. We had not gone far when it came home to us that we were going on one cylinder. Examination revealed a plug destroyed and exhaust-valve broken. Any spare valves? Tool-boxes and lockers turned out on the road. Nothing like a valve to be seen. Meanwhile I had got out a new plug. On applying it to the hole it went down out of sight. It was like putting a lady's hand into Daniel Lambert's glove. Nothing for it but to let the car descend a hill by gravitation and steer it on to the grass at the gate of a field. Returning to Uxbridge we relieved our minds per telephone to Long Acre, and got the assurance that a man was being despatched by next train with valves and plugs. We went to each train that came in. No man, no plug, no valves. Crestfallen to bed. Next morning, on reaching the station to go on by train, found, to our disgust, that a parcel had come the night before, but without a man, and that we could have got all put right that night. Since then I have formed the confident opinion that if Mark Tapley had lived in the early days of autocars, he would have lost his character. Nevertheless, such adventures have their uses. They teach valuable lessons.

Reminiscences would not be complete without a few words on two common troubles that afflict the (motoring) just—side-slips and punctures. Both of these would supply a volume of the Badminton Library in the way of anecdotes tragic and the opposite. As regards side-slips I shall mention only one. Mr. Edmunds was driving along Victoria Street, and intended to pass between two vehicles, when suddenly the guaranteed non-stop butcher's cart was driven by the unspeakable butcher's boy right into the vacant space. Mr. Edmunds did his best to pull up. The car did her best to turn round, and succeeded in going round all the points of the compass, all other vehicles flying before her pirouetting form. As she came round in went the clutch, and she rode gaily forward along the cleared road. Lady sitting behind leans over to Mr. Edmunds, and says sweetly, 'How delightful!—that was a most marvellous piece of steering. I wouldn't have missed seeing such a feat of skill for anything.'

Autocar punctures form the one exception to the rule against implicit belief in travellers' tales. No one can exaggerate about them, and no one would if he could. May I slightly alter the ancient prophet's word, and say, *à propos* of the pneumatic tyre, that 'man is born to trouble as the' dust 'flies upwards'? The autocarist who runs on pneumatic tyres has *atra cura* ever sitting behind him in his chariot. At any moment his wheel and his spirits may go down literally 'like a shot,' and the gay spark who is beating records in speed and in dust raising, may find himself trying to look happy in the middle of a crowd that gapes, and it may be jeers, and in the English sense shows itself the profane vulgar, while he is toiling out his soul, and blowing up his car in more senses than one.

As a contrast to this let me give my experience when bringing my car from the builders in Paris; 150 miles had to be run in one day from Beauvais to Dunkirk before 8 o'clock to catch the steamer for Leith. At St. Omer I found a carpet stud up to the head in one tyre, and at another halt I found a scar about an inch long in the other driving tyre. Each of these would have made it impossible for us to cover the 150 miles in time had

the tyres been pneumatic instead of solid. We drove on quite merrily, and after the car had reached Scotland and had been driven to Stirling, I got a cycle repairer to clean out the scar and fill it up with rubber. In doing so he probed on to something, and after working like a dentist at a stiff stump, he punched out a flint as big as a thumb-nail and more than an eighth of an inch thick, which was buried in the tyre, completely out of sight.

For the sake of any readers of Badminton who have never tested the fascinations of autocarism, I should like to recount some incidents which show that when the motorist's blood is up he will go through hardships equal to any that the most ardent votary of any sport will face, and these recitals give proof how motoring stimulates energy and invention.

Mr. Graham White gave an illustration on the 1,000 mile tour of what an autocarist will do rather than give in. I suppose it is the first instance of a human tiller being used for steering. On this run he on one occasion got down for a moment, asking his friend to steer, which the friend did by promptly running the car off the road and breaking the steering gear, putting the car in about the most hopeless disablement conceivable. There were many miles still to be traversed, and Mr. White accomplished the run by standing on the front of the car, and working the steering directly with his foot, thus bringing her through the crowded streets of Newcastle. I cannot tell you how he did it, but that he did it is certain.

Another case was that of Mr. Rolls driving a car from Paris in 1900. The story tells of the following mishaps : joints of waterpipe gone, bad junction to be replaced, bad cut in tyre of off front wheel ; chain loose, burst of back tyre, mackintosh loose and wound up in shreds on pump, leaking cylinder, whole upper ends of cylinders red-hot, pump jammed, leaks in radiator pipes, ignition tube burst twice, oil on the brakes, another tyre burst.

These were surely trials enough to break the back of resolution, but what the Anglo-Saxon and the Gael will do and dare can be appreciated when I mention that all these troubles

were encountered in mid-winter, sometimes in blinding snow and always in well nigh Arctic frost, most of them happening between dusk on one day and six in the morning of the next day, with icicles hanging from hair and beard, with the cold so intense that Mr. Hutchinson, from whom I quote, says that the following coverings were 'none too much,' 'a warm knicker-bocker suit, a Cardigan jacket, a waterproof hunting-apron, a heavy double-breasted ulster, a waterproof cape, and a cap with ear-flaps, so that only the eyes and nose were exposed.' The proceedings involved two hours' stop at one place, burning waste soaked in petrol under the radiators, Mr. Rolls on his back mending leaks, while the water trickled all over him and down his sleeves and freezing till his leather coat was stiff with ice. Yet after all this the party, when they had set themselves up at a village with some bread and cheese—and, I presume, though the chronicler does not say so, with some *vin du pays*—decided to make a start once more, at 2.30 A.M., and reached Havre only in time to go to bed at six in the morning. No wonder foreigners think the English insane.[1] But it is a thing to be thankful for that it is an insanity which has its compensations, for not only in sport is Great Britain a living witness that 'dogged does it.'

There is no space to write of the humours of automobilism, but as a kind of savoury the following must be quoted.

Colonel Magrath says:—

'In one of my first drives I met an elderly woman on a quiet road, proceeding to market. She got dreadfully startled at seeing the car, and when she arrived in Wexford told everyone that she met a carriage from the other world, with a horribly ugly demon driving it, and she knew at once that the carriage was sent to take her to hell, but, thank God! she had sense enough to make the sign of the Cross, when carriage and ugly driver vanished.

I presume in its own dust.

[1] Mr. Rolls thinks it is remarkable that I should have used this expression, as the hotel-keeper who received them at Havre, and who spoke a little English, said to the party, 'You English must be very "insanitary" to travel by road on such a night.'

Lord Edward Churchill relates how he got a motor-car to please his daughter—another instance of the ladies taking a lead, and curiously enough, as in the other case of Mr. and Mrs. Koosen, the gentleman, when he is too sad for words, refers you to the lady's diary. She describes how, having broken down, they had to

'wait ages for that horse, but at last a cart-horse turned up and was tied to the car with ropes. The man thought he would ride, my father would steer, I would keep things cheerful, and we would trot home. We did reckon without our host, and we may thank Heaven that horse was quiet. The man whacked it and it suddenly started on faster, so the car went on with a jump, the horse slowed down, and the natural consequence was the car ran hard on to the horse. The poor dear beast thought it its duty to hold back, so sat down on the dash-board and did not move. Of course it broke in half, my father in the agony of the moment having forgotten to put on the brake. Then I could have cried, but I did not, and there was more to follow. We suggested that the man had better walk as we had had enough of trotting. . . Then the horse got its leg over the rope and wound the rope round the wheel, then the wheel ran on its hoof, but it did not mind, and I was too sad to cry then, so I tried to laugh. We got home in the dark at eight o'clock. The boys and men in the village were insulting, and called out "Whoa Motor! that's the way to lead it whome," &c. Even my father smiled then. He said it was a beastly thing, and talked of selling it and a few other remarks of that sort.'

Nevertheless he too is still an ardent votary of the sport.

No reminiscences would be complete without a notice of the Thousand Miles Trial of 1900, which would by itself supply material for a volume. The demonstration of interest by the public was remarkable, and the strongest expressions of good will came from the very old people of both sexes. This was much remarked on at the time. I attribute it to the fact that these aged persons had been young when railways began to cover the country, and doubtless had heard them spoken against on all hands, prophecies made that they would ruin the country, denunciations thundered against them from all who had to do with

horse traffic, and frantic efforts made to keep them from being sanctioned. These people had lived to see the folly of all such proceedings and predictions, and therefore, their minds were free to wish success to a new mode of traffic, which might be expected to bring many of the benefits of quicker and cheaper transit past their own doors by the road.

Another fact which made a strong impression upon me was the small fatigue of long road journeys, as compared with horse-drawn travelling. I suppose Colonel Magrath and I were the two oldest men who made the tour, and we rode on a car having solid tyres. Yet I cannot recall having felt any sensation of weariness even after the longest runs (e.g. 125 miles per day) and we both came to the end as fit, if not more fit, than when we started. Another remarkable feature of the event was that, although it was the first demonstration of the power vehicle on a large scale, so many of the cars completed the whole journey, notwithstanding that many devices which were still in the experimental stage must have been on trial. And of the breakdowns which did occur, a very large proportion were vehicle failures, and not machine failures. It was not surprising that with little experience of vehicles travelling on ordinary roads at higher speeds than was possible with horse traffic, and with greater dead-weight, and with the power applied direct to the wheels instead of by haulage, defects in frames and axles and wheels should show themselves, until experiment had reduced the requirements to formulas that might safely be followed.

Of the kindness with which we were received everywhere, we shall all cherish a delightful recollection. But I think everyone who took part in the tour will join with me in saying that what will be most remembered was the extraordinary success of the organisation, by which so great an undertaking was carried on without a hitch. The labour, the forethought, and the tact that must have been put out cannot be measured. Mr. Claude Johnson, Secretary of the Automobile Club of Great Britain and Ireland, who originated the scheme, and

his subordinates deserve the place of honour in the history of Automobilism in this country up to the present time, and they will be wonderful contestants that succeed in wresting it from them in the future.

And now, as a last word, let me say what I believe will be said by all who have enjoyed this new sport : that we value it for two reasons. The one is that it will open up to the community many advantages both social and commercial. The other I feel very strongly. It is that it extends in a delightful manner the range of one's personal friendships, and promotes pleasant social intercourse of both sexes, in healthy enjoyment of fresh air and cheerful surroundings. May we continue to be a friendly guild. Pioneers must always keep close together. Union overcomes difficulty, and our motto should be

> Double the pleasure that friendship doth divide.

CHAPTER XX

SOME POINTS OF LAW AFFECTING THE OWNERS OF MOTOR VEHICLES

By Roger W. Wallace, K.C.
First Chairman of the Automobile Club of Great Britain and Ireland

Although the introduction of motor vehicles to be used for the purpose of conveying passengers and goods upon the ordinary highways was first brought about in England, yet because of the adverse legislation which this novel method of traction encountered, the credit for the modern development of what promises to be an enormous industry must fairly be given to France and Germany. In 1896, by the passing of the Locomotives on Highways Act the absurd restriction of forcing the proprietor of every mechanically driven carriage to cause his vehicle to be preceded by a man on foot with a red flag was abolished, and provided that his car were under a ton and a half in weight, he was allowed to proceed at the rate of twelve miles an hour. As this rate of speed did not allow the owner of the vehicle to drive faster than the ordinary speed of a horse, it soon became evident that mechanically driven vehicles had not sufficient scope allowed them to compete with ordinary horse-drawn carriages. The result was that the law was constantly broken, in most instances by persons who drove with consideration to the ordinary users of the highway, but in some instances by others who showed no such consideration, but on the contrary became a terror throughout the country. Having this state of things in mind the Automobile Club, in order to put matters on a proper basis, started a campaign in which they

proposed that the Act of 1896 should be amended chiefly in two respects : the first to prevent the improper use of motor-cars by causing a means of identification to be placed upon each car, and the second to abolish the speed limit. Accordingly a Bill was drafted and introduced into Parliament to effect these objects, and this Bill was soon afterwards practically adopted by the Government. Having regard to the unfortunate effect of the former legislation it might have been supposed that either the question would have received careful consideration in the House of Commons, or that a Royal Commission would have been appointed in order thoroughly to investigate all the circumstances of the case ; more especially having regard to the strong feeling which existed in the country, arising from a conservative sentiment of admiration for the horse and the irritation caused by a few owners of cars whose lack of decent behaviour discredited the whole movement. Such a course has been adopted in France, and a commission is still sitting, taking evidence and investigating with great minuteness all the recent developments of this new method of traction, not only in that country, but in others also, with a view to giving protection to all users of the road without at the same time hindering the development of the motoring industry, and preventing the users of the mechanically propelled vehicle from deriving the full benefits which should accrue from its adoption.

The Motor-car Act of 1903 is the result of the consideration which Parliament gave to this question, and it cannot be accepted as one which is in any way a credit to the Statute Law of this country. This was to be expected from the haste with which the measure was hurried through both Houses of Parliament. The Bill, as it emerged from the House of Lords, in the main was more satisfactory both from a motorist's and a public point of view, chiefly because there was no mention whatever of a speed limit in the measure. The position of moderate motorists with regard to this question has been very much misunderstood. They objected to the naming of any particular speed limit because they were of opinion it would cause a confusion in the minds of the public and the driver. The Act

as finally passed appears to give permission to the motorist to go at the rate of twenty miles an hour, and the driver may be led to consider that he is within his rights as long as he is keeping within this limit. Such, however, is not the case, as the Act of William IV., that is the Highway Act of 1835, was incorporated in the Locomotives and Highways Act of 1896 by enacting 'that a light locomotive shall be deemed to be a carriage within the meaning of any act of Parliament, whether public, general, or local, and of any rule, regulation, or bye-law made under any Act of Parliament.' The effect of this was to make it an offence to drive negligently so as to damage any person, animal, or goods on the highway, or to drive furiously so as to endanger the life or limb of any passenger. It is therefore obvious that one may be an offender at any time when going at a rate very much below twenty miles an hour, or, in fact, at any speed at all when the circumstances of the case require the driver to avoid placing any user of the highway in a position of danger. Sometimes it is not safe to go round corners at the rate of four miles an hour, and in many other circumstances it is quite evident that even that speed would be too great. It was in order to maintain a fair average rate of speed that the moderate motorist thought that when there was no obstruction or possibility of doing any damage, or causing any injury, he should be allowed to go at higher rates of speed. By law he must now never exceed a speed limit of twenty miles an hour, even for a short distance say of $\frac{1}{4}$ mile on a clear and open country road. If this law be rigidly observed it probably would result in an average rate of twelve miles an hour. The consequence of this special legislation for particular classes of traffic tends to create great confusion, and must in the end result in some general legislation codifying the law as regards the use of the highways by all classes of traffic.

The Act of William IV. covered most of the ground, and if legislation had been properly brought up to date and duly enforced, there would not be so great a congestion of traffic and such an unpractical use of the roads as is now common. For instance, under the Act of William IV. anyone wilfully hindering

another vehicle from passing is liable to a fine of 5*l.*; if he be the owner of the vehicle, a fine of 10*l.* All drivers are also required to keep their vehicles to the left or near side, so as to allow faster going carriages to pass. This provision is not enforced at all at the present time, which leads to motor-cars and other fast traffic passing slower vehicles on the near-side, this being a constant source of danger to both classes of vehicles and their occupants. Dealing with the recent Motor-car Acts, and the issue of the Local Government Board's regulations, an excellent circular letter accompanying its new regulations was compiled by the Local Government Board, explaining the objects and the scope of the amendments effected by the new Act. A careful perusal of this letter, which, however, is too long to produce in this chapter, would greatly help the reader to understand the course adopted by the framers of the regulations and the intentions of the Administrators of the Act. Generally speaking, the changes introduced by the new Act are, first of all—

(1) Registration of motor-cars [1] and the licensing of drivers.

[1] Every motor-car and motor-cycle must be registered with a county or a county borough council and carry a number assigned to it by the registration authority. It is within the power of the owner of a motor-car to register his vehicle in any county in the United Kingdom which he selects. The fee for registration is 1*l.* for a motor-car and 5*s.* for a motor-cycle. On purchasing a new car a new registration number must be obtained. It is not possible to transfer the number from the old car to the new car. The only way in which the old number can be retained is by applying to the County Council to cancel the previous registration and to assign the old number to the new car. The County Council may agree to do this, but the full charge of 20*s.* is payable. The purchaser of a second-hand car may have the registration amended so that his name appears as the owner, and a certificate of registration will be issued to him on the payment of the sum of 5*s.*, or in the case of a motor-cycle, 1*s.* No owner of a car may transfer his number temporarily to another car, and any owner who transfers his number temporarily will be guilty of an offence under the Act. A manufacturer or motor-car agent can procure a general identification mark for use on any car on payment of an annual fee not exceeding 3*l.*, but this general identification mark can only be used for any car on trial after completion or on trial by an intending purchaser. If used on any other car or for any other purpose on a car belonging to the manufacturer or agent, both the agent and the person so using the car with the general identification mark are liable to penalties.

(2) The repeal of the old maximum speed limit of fourteen miles an hour, and the substitution therefore of twenty miles an hour.

(3) Power was given to the Local Government Board to increase the tare limit (fixed by the Act of 1896 at 3 tons).

Further, in certain cases there is a power for the issue by the Local Government Board of an additional restriction of the maximum limit of speed to ten miles an hour, and for the prohibition or restriction for the driving of cars on specified highways of a narrow or other special character. Most of the local authorities throughout the country have preferred to rely upon the enactment of William IV. and Clause I. of the Motor Car Act of 1903, as to danger to life and limb and the various regulations issued by the Local Government Board on this point, instead of asking for additional restrictions; but in some cases, as at Winchester, a hearing has been demanded. This is now being resisted on several grounds, the principal of which is that the application of the local authorities to close all the roads within its district was too general, and that each portion of the road would have to be specifically dealt with.

As to the closing of the roads to motor traffic, motorists have pointed out that, by an Act of Parliament, if the road be not wide enough for the traffic of the neighbourhood, any two justices may sign a request calling upon the highway authority to enlarge the highway to the required width; and this provision has had a salutary effect in stopping such applications.

Apart from the above changes the Act provides for an increase in the penalties to which motorists are subjected, especially in cases where persons drive cars without holding licences, or when the licences are suspended on account of offences against the law. Besides the penalties existing under the old Act for infractions of other regulations of the Local Government Board, there are several new offences and new penalties punishable under the new Act for driving recklessly, negligently, or at an excessive speed as defined by the Act; for the first offence a penalty of 20*l.* is enforced, and for the second

offence 50*l.* or three months' imprisonment. The same penalties are also enforceable when a driver who has committed one of these three offences refuses to give his name and address or gives them falsely, or in the case of the owner if he fail to supply any information in his power which may lead to the identification and apprehension of the driver. These penalties are likewise enforceable if a car be used without being registered or without carrying the identification mark or if such mark be not easily distinguishable. The owner must also be careful that he does not drive his motor-car without a licence or employ any unlicensed person to drive, and he must be ready to produce his licence for indorsement when called upon.

A new provision similar to that under the Merchant Shipping Act, making it necessary to stand by in the event of an accident occurring at sea, is introduced, and a motorist failing to stop and give his name and address if required, after knowing of the occurrence of an accident owing to the presence of a motor-car on the road, is liable to a fine of 10*l.* for the first offence and 20*l.* for the second. For merely exceeding the speed limit a motorist cannot be imprisoned, but is liable in the first instance to a fine of 10*l.* and in the second instance to a fine of 20*l.* In addition to the above fines and liability to imprisonment, the offender may also have his licence endorsed or suspended for the remainder of the current year, and may be disqualified from obtaining a licence for any period the tribunal might think fit. In some of the above cases, such as reckless driving, absence of identification mark, and refusal to give name and address or produce licence, a motorist may be apprehended by any police-constable who actually observes the commission of the offence. There are other penalties provided by the Act, such as driving motor-cars on highways the use of which is forbidden by the Local Government Board, and the failure to produce a licence when demanded by a police-constable. In order to run the gauntlet of these various penalties and punishments which have been created, the motorist must always be alert to exercise the greatest caution

and consideration, inasmuch as in view of the increase in the number of motor-cars, and the consequent likelihood of the dissemination of dust, it is not to be expected for the present that the feeling of irritation will be allayed.

The Act is open to criticism from many points which want of space renders it impossible to discuss.

To one or two of them only I shall refer. Section 20 extends the provisions of the Act of 1896 and 1903 to a 'roadway on which the public are granted access in addition to a public highway.' This will probably prevent any races in England and Wales, Scotland or Ireland, even in private grounds, without special Acts of Parliament. For this reason it was decided to hold the selection trials for the Gordon-Bennett race of 1904 in the Isle of Man, which is exempt from the above-mentioned Acts.

It was supposed at one time that because of the use of the words 'a mark' it would not be necessary to carry more than one number plate, and that the regulation of the Local Government Board, which provides that two plates shall be carried, one before and the other behind, was *ultra vires*; but this proves not to be the case because of the Interpretation Act of 1889, which provides that 'words in the singular shall include the plural.' There will be considerable difficulty always for the motorist in the first instance, and a Court if called upon to do so, to define the meaning of the words 'having regard to the amount of traffic which might reasonably be expected to be on a highway,' when determining questions of reckless or negligent driving or going at an excessive speed. Subject to this question there remains no doubt as to the law on this point, because the decision of the Divisional Court in the case of Mayhew *v.* Sutton is now of effect by statute.

Perhaps by judicial decisions, when the courts look with more favour upon motor-driving, some alleviation may be given to the motorist by a favourable interpretation of the words 'having regard to all the circumstances of the case'; but the opposite may be expected during the period of three years

for which the Act is in force. The general effect of the legislation is to place motor-cycles upon exactly the same footing as motor-cars, except that the former need not carry so large an identification mark and trailers need not be separately registered. A person under seventeen may also, if over fourteen, drive a motor-cycle—which is more difficult than driving a motor-car—but if he be under seventeen he must not drive a motor-car.

When the particular offence charged against a motorist is excess of the speed limit, he cannot be convicted unless he be warned of the intention to prosecute at the time that he commits the offence, or unless notice of the intended prosecution be sent to him or to the registered owner of the car within twenty-one days. This provision will place the driver of a motor-car in an extremely awkward position; for his number may be taken several times in the course of a long journey, and when notice is given him he may not be in a position to produce the necessary evidence to disprove the case against him. There must in future under this section be evidence given by more than one witness as to the rate of speed. Under the section there have already been several cases tried to show that the opinion of the witnesses was not justified, because of the use of inefficient stop-watches. This, however, will soon be remedied, as cheap and efficient stop-watches are easily to be procured. Local authorities thenceforth will be obliged within their areas to set up sign-posts denoting dangerous corners, cross-roads, and precipitous places where such warnings appear to them to be necessary. It is a pity that those authorities are left to be the judges themselves as to where such posts should be erected.

Considering the serious questions and the heavy penalties which are imposed under this Act it would have been better to have allowed an appeal on questions of fact to the High Court of Justice; but appeals of this class are limited to a Court of General or Quarter Sessions against any conviction or order.

The Motor-car Acts now apply to all persons within the realm, even to those in the public service of the Crown, and the King is the only person who is not obliged to carry an identification mark.

In future the term 'motor-car' is to be employed instead of the expression 'light locomotive.'

The Local Government Board has been left, as under the Act of 1896, with very complete powers as to the making of regulations with respect to the use of constructions and conditions under which motor-cars may be used, and very complete rules have already been drawn up for this purpose. They appear in the Appendix. In Scotland the Secretary for Scotland is the authority, and in Ireland the Local Government Board for Ireland.

There are also regulations as to the storage of petroleum which have been made under the Act of 1903, and generally the effect of these is that petroleum spirit not exceeding sixty gallons for use for motor-cars may be kept without a licence if the restrictions laid down as to storage, &c. be strictly observed. Where these regulations cannot be observed or where it is intended also to sell spirit for use for motor-cars, a licence is necessary.

A careful study of the regulations issued from time to time by the Local Government Board with regard to use of lights, weight of cars, description of tyres, must be made by the motorist if he wish to avoid incurring the numerous penalties and punishments already alluded to.

The principal changes which have been made by the recent regulations issued on March 10, 1904, are that the maximum width of the motor-car between its extreme projecting points was increased from 6 ft. 6 in. to 7 ft. 2 in.

As to lights, the order of 1896 requires a car to carry a lamp on the offside, showing by night a white light in front and a red one behind. The lamp is still required in this position in front, but if there be a lamp at the back of the car which exhibits a red light, the requirement as to a red light on the front lamp need not be observed. Searchlights on motor-cars have been prohibited, as these lights have been found to frighten horses. It is also proposed in some way to deal with the question of dazzling lights, but it is hoped that motorists will

take action to avoid this cause of complaint so as to render a regulation unnecessary.

Tyres must be smooth, and where they touch the ground flat and of a width, if the car exceed 15 cwt., of not less than $2\frac{1}{2}$ inches. If of 1 ton weight but not exceeding 2 tons, of 3 inches, &c., but if a pneumatic tyre be used these conditions do not apply. Every motor-car with four wheels must have two independent and efficient brakes, arranged so that the application of either shall cause two wheels on the same axle to be so held that they are effectually prevented from revolving, or shall have the same effect in stopping the motor-car as if such wheels were so held.

In future a motorist must not only stop at the request of a police constable in uniform, but at the request of any person having charge of a horse or if either put up his hand as a signal for that purpose.

A very important regulation issued under the 1904 Act concerns the construction of cars, and in future the car must be so made as to prevent noise during enforced stoppage owing to the necessities of traffic.

There are several questions which naturally arise as to the law affecting owners and users of motor carriages on which there is some doubt. I have endeavoured in the following paragraphs to give an answer to some of the questions that are most frequently asked, and I hope these answers will be of some utility to fellow-automobilists.

The first question is one which applies to almost all owners, and is, whether it is necessary to pay a tax on motor mechanics as male servants or whether they can be classed as engineers and escape duty?

On the paper which is sent out by the Inland Revenue authorities every year will be found an extract from the Act 32 & 33 Vict. cap. 14, s. 19, which regulates the imposition of the duty payable on male servants. Apart from the end of the classification, which says that the master is liable to pay duty on all domestic servants, there is included specifically

'coachmen.' While we are not in the habit of calling our mechanics coachmen, yet there can be no doubt that a coachman is a man who drives a carriage, and although he may only be employed part of the day to drive the carriage, yet so is any other coachman who drives horses. It seems, therefore, quite clear that the duty must be paid if driving be his chief occupation. There is an idea prevalent amongst many people that it makes a difference whether the man wears livery or not; but this is a delusion; the only difference it could make would be to show more clearly that the man is a domestic servant.

Another question relating to taxes is, what tax must be paid on various motor carriages?

Most of the motors with which we have to deal are carriages with four wheels, and these must pay the ordinary carriage tax, which is, for a carriage with four or more wheels, to be drawn or propelled by mechanical power, the sum of 2*l.* 2*s.* There is also to be paid, under the Locomotives on Highways Act 1896, an additional duty if the weight of the locomotive (i.e. the motor carriage) exceed one ton unladen, but do not exceed two tons unladen, 2*l.* 2*s.*, or if the weight of the locomotive exceed two tons unladen, 3*l.* 3*s.* It should be noted that unladen in this Act means without including the weight of any water, fuel, or accumulators used for the purpose of propulsion. As a matter of detail it may perhaps be mentioned that the latter licences have to be obtained from a collector of Inland Revenue or a Supervisor of Inland Revenue. The lighter vehicles pay as follows:— A quad is a four-wheeled carriage, and therefore, pays as above, and so also does a tricycle used with a trailer, being classed as a five-wheeled carriage. For tricycles and bicycles the licence costs 15*s.*, they being classed as light private carriages, the definition of which includes 'any carriage propelled upon a road by steam or electricity or any other mechanical power.' Those whom it interests will find a report of a case tried on the question of whether a carriage licence should be taken out for a motor tricycle, the decision being in the affirmative, in

the 'Autocar' of May 26, 1900. This was confirmed on May 5, 1904 (see the 'Times'), in the case of O'Donoghue *v.* Moon. The Lord Chief Justice, in giving judgment, held that the machine (a motor bicycle) was none the less a carriage 'because the seat was very uncomfortable and the rider was very much shaken as he went along.'

There is a doubt current as to whether a master is liable to his driver under the Workmen's Compensation Acts. This is not so—the first Act, that of 1897, referring to servants in a factory and certain other employments; although some places which to the lay mind would scarcely seem to be included in the word 'factory' have been held by the judges to be so classed, there seems no possibility of a motor-car being held to be a factory. The Act of 1900 only extended the application of the former Act to the case of agricultural labourers, While on the subject of accidents it may be mentioned that insurances are procurable which will indemnify both the owner and anyone who may be driving him against injury or death.

There are other liabilities to which motor owners are subject in the same way as are all users of the highway. For instance, a child may be run over and injured. The law applicable to such accidents in the case of motor carriages is not different from that which applies to all other carriages—that is to say, the owner is liable both when driving himself and in any case in which his servant is driving on his master's service, but only when the accident is caused by an improper or negligent use of the highway, and when the injured party is not himself guilty of negligence which causes the accident. Against the above and other liabilities it would be well for owners to insure; a list of the best offices can be obtained by communicating with the Secretary of the Automobile Club.

In conclusion, the motorist must remember that the Motor-car Act does not relieve him from any liability he may incur by virtue of any Statute such as the Highway Acts or at Common Law.

CHAPTER XXI

AUTOMOBILE CLUBS

By C. L. Freeston

To say that the history of automobilism is that of its clubs is nearer the literal truth than a lapse into exaggeration. The debt which the sport and industry alike owe to these bodies, in every country where they have been formed, is incalculably great, and, however far the aspirations of the enthusiast may yet be from their ultimate fruition, the present stage of progress would not even have been within measurable reach but for the fostering care of the Automobile Clubs. Not in name merely, but in fact, they have been *Sociétés d'encouragement* throughout, and by trials and demonstrations in Great Britain, and races and hill-climbs abroad, have established the claims of the motor vehicle to the attention of the world.

The United Kingdom has been particularly fortunate in its Automobile Club, the exertions of whose numerous committees have been continuously arduous and self-sacrificing ever since its formation in 1897. By legitimate methods of propagandism it has gradually worn down a considerable amount of the prejudice and opposition to a new movement that were inevitable in a conservative country, and by its demonstrations of the practical utility of the motor vehicle it has entirely removed the evil but long-remaining impression of the appallingly abortive run to Brighton on November 14, 1896. Not the least important of the Club's services, moreover, has been its conversion of the public, and finally of Parliament, to the uselessness and ineffectuality of the twelve miles an

hour limit, which was raised to twenty by the Motor-car Act of 1903.

A brief retrospect of the Club's history may not be unacceptable to the more recent recruits to the pastime. In the summer of 1897 a few pioneers met, and mutually agreed to form an Automobile Club. On the 10th of August the Club was formally constituted. Premises were then acquired at 4 Whitehall Court, S.W., and were inaugurated on December 8. By this time 163 members had enrolled themselves, and such good progress was made that by the end of 1898 the membership had attained a total of 380. But already these early devotees were called upon to substantiate their faith, for the revenue of the Club was drained by three extraordinary sources. These were an initial expenditure of 540*l.* in the establishment of the Club; law costs amounting to 148*l.* 6*s.* 4*d.*, owing to a dispute about its title; and the placing of 1*l.* on deposit from every subscription received, in accordance with the articles of association. A guarantee fund, however, was formed, and amounted to 1,521*l.* at the close of the year. Mr. Roger W. Wallace, K.C., was the first chairman, and held the office until 1904; Mr. Evelyn Ellis and Mr. Frederick R. Simms (the originator) were elected vice-chairmen, with Mr. Frank H. Butler as Hon. Treasurer, Mr. C. Harrington Moore (the Club's first organiser) as Hon. Secretary, and Mr. Claude Johnson as Secretary.

From the outset the Club became an active and virile force in the automobile movement. Its fixture list comprised tours and week-end runs, club dinners, lectures and discussions, and general meetings. It exerted its influence, with others, in preventing the introduction of vexatious clauses affecting motor vehicles in Bills seeking powers for local authorities; it assisted in opposing the Westminster Tramways Bill; and it compiled a list of motor-spirit stores. In July of the same year, moreover, an amalgamation was effected with the Self-Propelled Traffic Association (which had been previously founded by Sir David Salomons, Bart.), and the Club thereupon became the

only recognised authority on automobilism in the United Kingdom.

In the following year the membership grew apace, and on December 31, 1899, the roll was as follows:—Founder members, 287; life members, 21; ordinary, 187; ordinary town, 47; ordinary country, 41; supernumerary, 3; a total of 586. The chief event of the year was the holding at midsummer of a show of motor vehicles, in the Old Deer Park, Richmond. Races, time tests, and hill-climbing trials were conducted in connection with the exhibition, which extended over a period of eight days. The labour of organisation had been considerable, the show committee having held no fewer than forty-three meetings; but public prejudice was still strong enough to make the undertaking a financial failure, and it resulted in a loss of no less than 1,600*l*.

More satisfactory were the other functions of the year, for in addition to several tours a series of brake tests was carried out on Petersham Hill, in the presence of Local Government Board inspectors; an exhibition of motor vehicles was held at Dover, in connection with the meeting of the British Association; and a conference of manufacturers of motor waggons was organised to discuss the suggested raising of the tare limit. The anniversary of the coming into operation of the Locomotives on Highways Act, 1896 was celebrated on November 14 by a run to Sheen House.

Greater activity than ever characterised the year 1900, during which the membership rose to 710. In four Club tours alone a distance of 1,196¾ miles was covered, while the year will ever be memorable for the organisation of one of the most remarkable demonstrations in the history of locomotion. This was the famous Thousand Miles Trial from London to Edinburgh and back; it was strikingly successful, and did much to remove the public apathy. Day exhibitions of the competing vehicles were held in seven large towns *en route*, and a week's exhibition of the successful cars followed at the Crystal Palace. A trade show of motor-cars under the ægis of the Club, but

managed by Messrs. Cordingley, was also held at the Agricultural Hall, from April 14 to 21. Numerous house dinners and discussions were arranged during the year, together with three 100-miles trials on the Oxford Road, and electric trials at Chislehurst. Automobile gymkhanas took place at Ranelagh and Sheen House, and a fête at the Crystal Palace. The issue of a Club gazette, under the title of 'Notes and Notices,' was begun, to be subsequently converted into a weekly 'Journal,' while eight branches of the Club were established throughout the United Kingdom. As a preliminary to an extensive campaign in 1901, moreover, demonstrations of motor-car efficiency and control were held before the County Councils of Warwick and East Suffolk, in consequence of a hostile agitation having been set afoot in favour of the reduction of the speed limit to ten miles an hour. In several directions during the year the Club was able to secure a reduction of absurd tolls levied on motor-cars, and the removal of objectionably restrictive clauses in a corporation Bill.

In 1901 the conversion of the County Councils was successfully taken in hand. Towards the close of the previous year a letter of twenty-six pages of printed matter had been forwarded to 4,412 County Councillors and sixty-five clerks to County Councils, who were now invited to attend a big central demonstration in the metropolis, or to arrange for demonstrations in their own locality. Cars were sent to various parts of the country for this purpose in the early part of the year, pending the great demonstration in June. The last-named function extended over three days, between three and four hundred County Councillors being driven on cars to Sheen House, and there entertained to luncheon before the return to town. It is certain that the ease with which the cars could be controlled was a complete and gratifying revelation to the majority of the visitors. The Chief Constables of the English and Welsh counties were also approached by the Club in the frank and friendly manner which has characterised its propagandist efforts throughout. They had been circularised in the

same way as the County Councillors, and were also invited to a demonstration in London on February 26th, which was well attended. Following a drive to Sheen House and back a conference with the Chief Constables was held at the Automobile Club premises, when the visitors were afforded every opportunity of stating their views. A demonstration was also given at Leicester on June 29th, before a large body of municipal and county engineers assembled for their annual conference. A noteworthy achievement of the year was the raising of the speed limit in Scotland from ten to twelve miles an hour, the Secretary of State assenting to that alteration upon representations from the Club. In May the Motor Union was formed in connection with the Club, as a defensive association for the protection of the civil rights of members. A special Legislation committee was also appointed in August, with two of his Majesty's judges among its members, to consider the provisions of a new Bill for the regulation of motor vehicles. The Club held three quarterly hundred miles trials, two consumption trials, two hill-climbing trials, and a week of test trials at Glasgow. Several tours and runs also took place, the anniversary run to Southsea on November 16th being an enormous undertaking, considerably over a hundred cars making the journey, notwithstanding a dense fog at the start. The year closed with a total membership of 1,154.

Very early in 1902 the Club's activities were displayed in the shape of an important trial of brake-power in Welbeck Park, in the presence of the chief engineering inspector of the Local Government Board. The results were dramatically effective, even very heavy cars being stopped inside two lengths at a speed of eighteen miles an hour. At the annual meeting of the Club on February 27, it was shown that the finances were in a satisfactory condition, notwithstanding the heavy expenditure on the County Council campaign. By a decision to migrate to new and much larger premises at 119 Piccadilly, the Club entered upon a new chapter of its history.

The transference took place on December 1 of the same year, since which date the membership has more than doubled itself, notwithstanding the increase of the annual subscription to eight guineas. At the last annual meeting on March 10 the

The Automobile Club of Great Britain and Ireland, 119 Piccadilly

total number of members was stated to be 2,515, or more than any other automobile club in the world.

Of foreign automobile clubs the number is already considerable; if the various provincial clubs are taken into account a

total of about one hundred and twenty is attained. The most representative organisations of Europe and America are enumerated below, the details as to their achievements and respective constitutions being compiled from particulars supplied by their officials and from other available sources.

FRANCE.—The Automobile Club de France, which was founded in 1895, is the oldest of automobile clubs, and until recently was the largest and most influential. Its headquarters in the Place de la Concorde, Paris, are on perhaps the finest site in Europe, and are quite palatial—in fact, they constitute one of the handsomest club-houses in the world. A handsome private theatre, a spacious *garage* and pleasant roof-gardens are among the special features of the establishment. The French club has three honorary presidents, Vice-Admiral Bonie, M. Marcel Deprez, and M. Georges Berger. The active president is the Baron de Zuylen de Nyevelt de Haar, who has ever been foremost in furthering the interests of the Club and of automobilism generally. The vice-presidents are the Marquis de Dion, M. Henri Menier, and M. Ed. Muller. Other officers are as follows: general secretary, M. Alfred de Rollepot; treasurer, M. André Lehideux-Vernimmen; members of the administrative council, MM. Abel Ballif, Marquis de Chasseloup-Laubat, Comte de la Valette, Comte Récopé, and Gustave Rives; secretary, M. Chas. Ward. The annual subscription is 200 francs, and there are 2,100 members. With regard to the organising and propagandist work of the Automobile Club de France, it may be said that this has chiefly been confined to the promotion of races, the results of which have exerted a widespread and potent influence in demonstrating the capabilities of the motor vehicle. The races held under the immediate direction of the Club have been as follows: 1896, Paris-Marseilles-Paris; 1898, Paris-Amsterdam; 1900, Paris-Lyons (Gordon-Bennett Cup), Paris-Toulouse; 1901, Paris-Bordeaux (Gordon-Bennett Cup), and Paris-Berlin; 1902, Paris-Vienna; and 1903, Paris-Madrid. The other French races, referred to in the remarks in the Appendix (p. 433) on 'Races and Trials,' have been arranged by other clubs or various journals. The Club has also held

a number of competitions as under: 1897, Concours de Poids Lourds, or 'Heavy Weights,' answering to the motor-waggon trials held at Liverpool; 1898, Concours de Poids Lourds, Concours de Fiacres; 1899, Concours de Poids Lourds, Concours de Fiacres, and Concours d'Accumulateurs; 1900, Concours de Voitures de Tourisme, Concours de Motocycles, Concours de Fiacres, Concours de Voiturettes, Concours de Véhicles de Petite Livraison (light delivery vans), and Concours de Poids Lourds. The last six were held in connection with the Exposition Universelle of that year. During the continuation of these trials the competing vehicles are housed nightly in a building under the surveillance of the Club, and the technical committee carefully notes the weights of water, fuel, grease, &c., or the quantity of electrical energy required by each. An official observer also accompanies each vehicle whilst on the journey, notes all the stoppages, repairs, and speeds arrived at on various sections of the road, and full reports are prepared and printed after the completion of the trials. It should also be added that the Club has taken a leading part in the promotion of annual automobile shows in Paris, at which the latest products of the French manufacturers have been displayed, and which have attracted visitors from all parts of Europe.

NORMANDY.—The Automobile Club Normand has its headquarters at 4 *bis* Boulevard d'Orléans, Rouen, near the Gare d'Orléans and the Place Carnot. It was founded in January 1900, with M. Ballif, of the Touring Club de France, as *Président d'Honneur*. The chief officers are as follows:—President, M. Bridoux; vice-president, M. Mouy; treasurer, M. Naltet; secretary, M. Bonnemain. The club premises include a *garage*, open day and night, and members of the Automobile Club of Great Britain and Ireland may house their cars at the following reduced tariff on presentation of their cards:—For a car weighing over 400 kilogrammes (8 cwt.), 1 day, 1 fr. 80 c.; 1 month, 9 frs. For a voiturette, 1 day, 1 fr.

35 c., 1 month, 6 frs. 30 c. Cleaning, 3 frs. 15 c. for a car, and 2 frs. 25 c. for a voiturette.

BORDEAUX.—The Automobile Club Bordelais was founded in May 1897, and its headquarters are at 2 Place de la Comédie, Bordeaux. Its chief officers are as follows :—President, M. D. Creuzan ; vice-president, M. Lanneluc ; treasurer, M. Igusquiza ; secretary-general, M. L. Lestonnat ; secretary, M. Puisarnand ; librarian, Mr. J. S. Walton. There are about 250 members. The club conducts races for automobiles and balloons, and fortnightly tours. The annual subscription is 50 frs., with a like amount as entrance fee.

NICE.—Of provincial clubs the Automobile Club de Nice is undoubtedly the most active and important. It was founded in 1897 as the Auto-Vélo Club, but changed its name in 1900. From its foundation the Club has annually held races, competitions, and tours of an international character, with a view to popularising the new means of locomotion and improving the vehicles themselves. The Club was also the originator of the battles of flowers, *concours d'élégance*, &c., which have been widely imitated. Most of the races are held in the spring, and the 'Nice Week' has become one of the leading events of the automobile year. The president of the Club is M. Jacques Goudoin ; the vice-presidents are MM. Ernest Sardou and Paul Chauchard ; the treasurer is M. Ferdinand Crossa, and the secretary, M. Pierre Clérissy. At 5 Boulevard Gambetta the Club has a villa standing in its own garden, a pavilion restaurant, and a spacious *garage*, the background of which is formed by a panorama of the Bois de Boulogne. There are 308 members of the club, the subscription to which is 50 frs., and the entrance fee 20 frs. A weekly gazette, the 'Automobile Revue du Littoral,' is issued under the direction of the Club.

DORDOGNE.—The Dordogne Automobile Club, the full title of which is Le Véloce Club Périgourdin et Automobile

Club de la Dordogne, has its headquarters at the Grand Hôtel du Commerce et des Postes, 8 Place du Quatre-Septembre, Périgueux. Its officers are :—President, Le Comte F. de Fayolle ; treasurer, M. Louis Didon , secretary, M. H. Soymier. There are fifty-eight members. Members of the A.C.G.B.I. touring in this district may store their cars at the V.C.P.A.C.D. garage without charge, and will be afforded every assistance by the officials.

Belgium.—The Automobile Club de Belgique was founded on May 7, 1896, and its headquarters are at 5 Place Royale, Brussels. The King of the Belgians is its 'Haut Protecteur,' and Prince Albert of Belgium its honorary president. The officers for 1902 are as follows :—President, Comte de Henricourt de Grünne ; vice-presidents, MM. de Savoye and de Limburg-Stirum ; treasurer, M. d'Aubreby ; secretary, Comte de Villegas de Saint-Pierre. In various ways the Belgian club has been active during the past two years. It holds an annual race meeting at Spa, and also a 'Fête du Cinquintenaire,' while in 1901 a combined 'Tour de Belgique' was successfully undertaken. The Club also devotes its efforts to the improvement of the Belgian highways, the securing of a uniform code of police regulations concerning automobiles, and the removal of foreign customs restrictions. In March, 1902, the Club organised an automobile exhibition in Brussels.

The Netherlands.—The Nederlandsche Automobile Club was founded in 1898. As yet it has no quarters, but correspondence may be addressed to Herr Joannes D. Waller, the secretary, at Driebergen, near Utrecht. The other officers are :—President, Le Chevalier de Nahuys ; treasurer, J. P. Backx. The annual subscription is 25 guilders (*2l. 1s. 8d.*) and the entrance fee ten guilders (*16s. 8d.*). There are 135 members. The Club has over eighty hotels under contract, and a similar number of benzine depôts, of which it publishes lists.

Switzerland.—The Automobile Club de Suisse has headquarters at the Hotel de la Métropole, Geneva, and was founded in December 1898, and has 575 members. The officers are :—President, M. Aloys Naville ; vice-presidents, MM. C. L. Empeyta and Dr. S. Keser; secretary-general, M. Paul Buchet ; technical secretary, M. Wm. Humbert; treasurer, M. François Panchaud. The annual subscription is 20 frs. The telegraphic address is 'Autoclub, Geneve,' and the telephone number 2,939. It was decided on January 10, 1904, to divide the Club into four sections of Bâle, Geneva, Vaud and Valais, and Zürich respectively.

Germany.—The Deutscher Automobil Club was founded on July 31, 1899, and has 450 members. Its headquarters are at Sommerstrasse 4A, Berlin. H.I.H. the Grand Duchess Anastasie von Mecklenburg-Schwerin is Patroness, and H.R.H. Duke Frederick Franz IV. von Mecklenburg-Schwerin and H.E. General von Podbielski, Secretary of State, are honorary members. The president is H.I.H. the Duke of Ratibor, and the vice-presidents are Prince Christian Kraft zu Hohenlohe-Oehringen and General von Rabe. The secretary is Baron von Molitor. The annual subscription is 100 marks and the entrance fee 100 marks. Lady members pay half these amounts.

Austria.—The Oesterreichischer Automobil Club was founded on February 6, 1898, and has 550 members. Its headquarters are at Kärnthnerring 10, Vienna. The officers are :—President, Prince Alexander zu Solms-Braunfels ; vice-presidents, Count Carl Schonborn-Buckheim and Herr Georg Goebel; secretary, Herr Josef Fellner, Kirchberggasse 7, Vienna. The subscription is 50 kronen, and the entrance fee is 60 kronen. Members of automobile Clubs with which reciprocal arrangements are in force may use the club premises for a period

of four days on presentation of a special card. The A.C.G.B.I. is one of the Clubs in question. The Austrian Club has an active membership, and promoted the Paris-Vienna race of 1902.

ITALY.—The Veloce Club e Club Automobilisti d'Italia was founded in 1897. Its headquarters are at Milan. The officers are:—President, Cav. F. Johnson; vice-president, Signor O. Odorico; secretary, Cav. F. Pizzagalli. There are 974 members, of whom 258 are ladies. The subscription is 40 *lire*, and the entrance fee 10 *lire*.

AMERICA.—The Automobile Club of America was founded on June 7, 1899. Its rooms are located in the Plaza Bank Building, 753 Fifth Avenue, New York, at the entrance to Central Park. There are 400 active and 98 associate members. The subscription for active members is 50 dollars per annum, with 100 dollars entrance fee; for associate members the subscription is 25 dollars and the entrance fee 50 dollars. The officers are as follows:—President, Winthrop E. Scarritt; vice-presidents, H. R. Winthrop, Harry Payne Whitney, and W. K. Vanderbilt, jun.; treasurer, Jefferson Seligman; secretary, S. M. Butler. The American Club has chiefly devoted its efforts to obtaining reasonable legislation in reference to the use of the highway by motor vehicles; the carriage of gasoline motor vehicles on ferries; and the furthering of the good roads movement throughout the country by the circulation of literature and by the arduous work of a 'good roads committee' of the Club. The encouragement by the Club of the manufacture of motor-cars has taken the form of two successful automobile exhibitions held in Madison Square Garden in November of 1900 and 1901 respectively; while in September, 1901, a 500-miles Endurance Contest was organised from New York to Buffalo over exceedingly rough and bad roads. There were eighty starters, of which forty-two finished at Rochester, some forty miles from Buffalo, where the contest was abandoned

owing to the assassination of President McKinley. In racing matters the Club has formulated a set of racing rules under which licences for race meetings have been granted to some ten or twelve clubs throughout the country. The Club has also assisted in the formation of nearly all of the thirty odd clubs which now exist in the United States, and has established reciprocal relations with the leading automobile clubs of Europe. Fortnightly Club runs are held during the spring and autumn, and in winter fortnightly suppers and lectures are given at the headquarters. A library has been established at the latter, containing all the automobile literature and periodicals of the world. The privileges of the Club are open to members of the Automobile Club of Great Britain and Ireland for a period of ten days, on production of an official card of introduction.

CHAPTER XXII

MOTOR CARS FOR MEN OF MODERATE MEANS

By Claude Johnson

The following extract from Mr. Kennedy Jones' article in the 'New Liberal Review' of May, 1903, shows that there is considerable difference of opinion as to the cost of the upkeep of a motor-car. He wrote:—

'To talk of being able to maintain a motor-car capable of running 150 miles, day in and day out, on less than it takes to keep a carriage horse in first-class condition is, as I hope to show by dealing in detail with my motor expenses, merely mischievous nonsense.'

Mr. Kennedy Jones shows that his 10 h.-p. Panhard cost him for fuel, lubrication, tyres, repairs and overhauling, during eight months, 197*l.* 9*s.* 3*d.*, or at the rate of nearly 4*d.* per mile. In this chapter, an endeavour is made to arrive at an estimate of the cost of running motor-cars of various powers for the guidance of those who contemplate the purchase of an automobile.

A vast amount of misunderstanding has arisen owing to owners having quoted as the cost of upkeep of a car the amount of their expenditure on repairs and renewals during the first year of their ownership. They overlook that the original price paid by them for the car included the cost of tyres, gear-wheels &c. which may not require renewal in the first year, but may do so during the next few months.

For instance, a set of tyres may last a year. The expenditure may be confined to a few inner tubes. The cost of tyres during the first year of the life of a car may therefore be 6*l.*, and the owner cheerfully asserts that his tyres have cost him only 6*l.* for a year. In the thirteenth month, however, a new set of tyres may be required, which will bring the cost of tyres for the second year to perhaps 66*l.*, and this would be the true cost of upkeep.

TYRES

It is very difficult to estimate the cost of the upkeep of tyres. Solid tyres costing 33*l.* a set have been known to run 10,000 miles, bearing a total load of two tons. This works out at ·8 of a penny per mile. But the car was used mostly in London and was never driven at more than 15 miles an hour.

The life of tyres depends on—

(1) Speed of the car.

(2) Use of brakes and application of power in starting.

(3) Weight carried.

(4) Sectional diameter in relation to weight and speed.

(5) Speed in turning corners.

(6) Road surface.

The principal expense arises from the fact that manufacturers have found a difficulty in making tyres of uniform quality. One set may wear for 5,000 miles, the next give way after 2,000 miles.

The Automobile Club's tyre trials showed that pneumatic tyres fitted to cars weighing with passengers over $1\frac{1}{2}$ tons and of 12 h.-p., driven (of course with great consideration for the tyres) at about 20 miles an hour, would last for 4,000 miles. The tyres on the driving wheels were in some cases almost 'done for,' while those on the front wheels remained in good condition. They cost about 58*l.* per set. Probably no tyre company would undertake the upkeep of tyres on a car which with passengers weighs 28 cwt., and which is capable

of travelling on its top speed at 40 miles an hour, at a rate of $2\frac{1}{2}d.$ per mile; for, on an average, the cost of tyres on such a car will not amount to much less.

On the other hand, on a 6 h.-p. light car, capable of travelling on its top speed 28 miles an hour, the cost of tyres should not exceed $1\frac{1}{4}d.$ per mile.

Estimates of Maintenance of Tyres for 10,000 *miles*

H.-p.	Top speed in miles per hour	Weight with passengers	Cost of maintenance	
			per 10,000 miles	per mile
		cwt.	£	*d.*
5	27	11·4	20·8	0·5 [1]
10	35	24·3	79·3	1·9
15	40	28	93·7	2·25

I may here warn readers not to buy tyres until they are required, for they deteriorate very quickly, even if not used at all, and especially if exposed to strong daylight.

FUEL CONSUMPTION

This can be arrived at from the official records of the Automobile Club's reliability trial, 1903 (1,000 miles).

These records show that the consumption of petrol per 10,000 miles was as follows:

(*a*) 5 h.-p. to 6 h.-p. voiturettes, from 262 to 427 gallons, or from ·39 to ·64 of a penny per mile; average ·51*d.* per mile.

(*b*) 7 h.-p. to 10 h.-p. light cars, from 360 to 430 gallons, or from ·54 to ·64 of a penny per mile; average ·59*d.* per mile.

(*c*) 10 h.-p. to 16 h.-p. cars, from 332 to 590 gallons, or from ·49 to ·88 of a penny per mile; average ·68*d.* per mile.

(*d*) 16 h.-p. to 24 h.-p. cars, from 510 to 670 gallons, or from ·76 of a penny to one penny per mile; average ·88*d.* per mile.

The report indicates that some cars were very extravagant in their fuel consumption. These have been omitted from the

[1] I am assured that the pneumatic tyres on very light voiturettes cost only $\frac{1}{2}d.$ per mile for maintenance, but I should be inclined to say $1d.$ is nearer the mark.

above summary as the public should not buy them. Steam cars are also omitted. Petrol is taken at 1*s.* 3*d.* per gallon.

ENGINE AND RUNNING GEAR

The cost of upkeep of engine and running gear is largely regulated by the skill, care, and knowledge of the driver or mechanician. Many gentlemen of moderate means own voiturettes which they can keep in running order themselves, with the aid of a gardener or boy to wash the car and do the dirty work—such as filling grease-cups, &c.

A well-made voiturette, such as the De Dion, might be kept in running order (as far as the engine and running gear and carriage work are concerned) by an expenditure of 20*l.* for every 10,000 miles = ·48*d.* per mile.

A good two-cylindered 10 h.-p. car would probably cost for renewals, repairs, and adjustment of engine and transmission gear not less than 1·25*d.* per mile, or, for 10,000 miles, 52*l.*

A 15 h.-p. car with a 40 miles per hour top speed would probably cost 80*l.* per 10,000 miles, or say 2*d.* per mile.

SUMMARY

Cost per 10,000 *Miles*

	5 h-p. very light voiturette	10 h.-p. 2-cylindered light car	15 h.-p. car
	£	£	£
Tyres (pneumatic) .	[1] 20·8	79·3	93·7
Petrol, at 1*s.* 3*d.* per gallon . . .	21·5	24·6	36·8
Gear body renewals	20·0	52·0	80·0
Lubricants, electricity for ignition batteries, &c. . .	5·0	7·0	10·0
Totals . . .	67·3	162·9	220·5

[1] This item I look upon as doubtful. I am told it is correct, but I should be inclined to double it.

Much of the information in this chapter is derived from a paper prepared by Captain Kenneth Campbell, D.S.O., and read by him before the Automobile Club. This careful compilation contained a great deal that is of special value to all users of motors, and particularly to the more inexperienced owners. The writer gave a caution against the 'repairer sharks,' as they are called in America, recommending the motorist to deal with the builders of his car whenever possible, it being to their advantage to retain their customer's good-will. Captain Campbell had taken the trouble to calculate as nearly as he could the saving he was able to effect by using his car instead of going by train for summer holidays, visits, shooting expeditions, &c., and reckoned it at a little over 32*l.* per annum; furthermore he believed that he saved some 40*l.* in cab hire and livery stable bills when in town. These figures are perhaps of no particular importance, for the reason that different people's holidays, visits, and London cabs, &c. vary so considerably, but the estimate is perhaps worth quoting. That there is a saving in doctor's bills from the benefits derived from open air excursions Captain Campbell also regards as probable.

An ordinary stable with a coach-house and three stalls is readily convertible into a motor-house, and a groom of fair intelligence can be taught to drive a car.

Captain Kenneth Campbell has given me his revised figures with his 10 h.-p. Lanchester car as follows:—

Tyres.—Including the cost of the original tyres fitted to the car, and new tyres since purchased, repairs and re-rubbering on a car weighing (including passengers, luggage &c.) 27 cwt., cost him, for 16,000 miles, $2\frac{1}{2}$*d.* per mile.

Maintenance of gear, engine and body cost him 2·2*d.* per mile.

Fuel and Lubricants.—Captain Campbell finds that these work out at 1*d.* per mile. This, therefore, gives a total cost of 5·7*d.* per mile.

The cost of motor-groom and coach-house per annum Captain Campbell gives as follows :—

	£	s.	d.
Wages of motor-groom at 25*s.* a week . . .	65	0	0
Livery, clothes, and boots	20	7	3
Licence for groom	0	15	0
Licence for motor-car	2	2	0
Rent of stables	30	0	0
Taxes on stables	8	17	4
Light, say	1	0	0
Water	1	12	4
Christmas present	0	10	0
Total	130	3	11

He figures out that to keep a good car running efficiently will cost, all told, about 335*l.* per annum, not including painting and varnishing.

7 H.-P. LIGHT CAR

The following particulars may prove of value to those who contemplate buying a motor-car. They are kindly supplied by a gentleman who is engaged in the Post Office Telegraphs. He uses a 7 h.-p. New Orleans car, which weighs about 10 cwt. and has a top speed of perhaps twenty-five miles an hour. The car has run 15,000 miles in two years.

Tyres.—The tyres have been run 16,500 miles, as they were changed over to a sister car for a few weeks. The upkeep of six complete tyres and the purchase of two spares have cost 48*l.*, which for 16,500 miles works out at ·63*d.* per mile. If the purchase of the two spare tyres be deducted, the cost is reduced to 33*l.*, or for 16,500 miles at under ½*d.* per mile. It must be borne in mind that the cost of the tyres supplied with the car is not included in the above calculations. If the cost of the original tyres be added, namely, 26*l.*, it will be seen that the cost of tyres for the 16,500 miles was 74*l.*, or 1·07*d.* per mile.

Gear, Engine, and Body.—The cost of upkeep, including new gear, painting the car twice, and general overhauling

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every six months was, for 15,000 miles, 77*l.*, or 1·23*d.* per mile.

Fuel.—For 16,500 miles the fuel cost 33*l.*, or ·48*d.* per mile.

Lubricants, &c., for the same distance cost 7*l.*, or ·1*d.* per mile.

The total cost per mile, therefore, appears to be as follows :—

	d.
Tyres	1·07
Gear, engine, and body	1·23
Fuel	0·48
Lubricants	0·10
	2·88

omitting depreciation, insurance, rent of stables, man, &c.

8 H.-P. CAR

A gentleman who has used an 8 h.-p. De Dion car for two years as a means of daily transport between his house and business in London and back again, has kindly supplied me with the details of the cost of upkeep during the second year :—

He travelled in the year 4,350 miles.

Tyres.—During the second year he found it necessary to have three entirely new outer covers and to have two others re-treaded, at a cost of 23*l.* 6*s.* 1*d.*, but he calculated that these would carry him for several months. At the same time, this sum really represents what it cost him for tyres during the first year, and it works out at 1·28*d.* per mile.

Gear, Engine, and Body.—The cost of repairs done by Messrs. De Dion, Bouton, chiefly the time spent in adjusting the gear, tightening the driving shaft, adjusting the ignition, &c., amounted to 9*l.* 4*s.* 3*d.*, and renewals, including the cost of two dry batteries, a new coil, a brake drum, sparking plugs, platinum tip screws, &c., amounted to 9*l.* 5*s.* 6*d.*, or a total of 18*l.* 9*s.* 9*d.*, which works out at 1·02*d.* per mile.

Fuel.—One hundred and eighty-eight gallons of petrol

were consumed in a distance of 4,350 miles, or, at 1*s.* 3*d.* per gallon, ·64*d.* per mile.

Lubrication and Luminants.—Eight lbs. of carbide at 8*d.*; 121 lbs. of grease at 1*s.*; 10 pints of 'P' oil; 23 pints of 'D' oil, paraffin, and sundries; cost, 2*l.* 10*s.* 0*d.*, which is ·13*d.* per mile.

Therefore, omitting the cost of stabling, depreciation, insurance, and man, we find that the cost of running per mile has, in this case, amounted to 3·07*d.*

10 H.-P. CAR

Mr. Kennedy Jones, in May, 1903, wrote as follows to the 'New Liberal Review,' but as apparently he has not kept his mileage with any severe accuracy, I have not worked these figures out into the cost per mile:—

But if it is necessary to emphasise the fact that a motor-car capable of travelling 150 miles a day cannot be maintained at a cost of 166*l.* a year—Mr. Norman's figures for a 10 h.-p. car—I have a further budget relating to the running of a 10 h.-p. car for a period of eight months. The car cost 834*l.* 8*s.* 9*d.* before it was fully equipped, in the eight months it ran close upon 12,000 miles, and its cost figures thus in the ledgers, which are carefully kept:

	£	*s.*	*d.*
Petrol	38	13	2
Oil, grease, polish, carbide, petroleum, &c.	17	14	8
Garage on road	8	14	6
Help cleaning, &c.	5	3	6
Chauffeur's wages	78	0	0
,, expenses on road	12	10	4
Tyres:			
Two new tyres	24	15	0
Repairs to covers	9	15	6
Two new inner tubes	4	15	0
Solution, patches, &c.	2	8	6
Repairs and renewals:			
Valves, sparking plugs, washers, &c.	7	4	6
Two sprocket wheels	2	15	0
Pair of driving chains	3	8	0
Spare driving chain	1	10	0
Time on repairs and sundries, bolts, springs, pins, &c.	19	9	11
	236	17	7

To this sum must be added 65*l.*, the amount paid for overhauling, rebrassing, and repairing the car at the end of the eight months—a charge which was absolutely necessary in order to put the engine in a position to continue to do its work efficiently. This brings the cost of maintenance to about 9*l.* a week, without allowing for depreciation.

The above is an example of what a car may cost a man who leaves its care entirely to a mechanic.

The following interesting particulars appeared in the 'Automobile Club Journal,' written by a Doctor of Medicine, a member of the Club. It will be noticed that the car is run on solid tyres and is belt-driven.

Having noticed a number of letters in the Journal from members of my profession, under the heading of 'Motor-Cars for Medical Men,' I venture to send you my experiences, in the hope that they may be of some use to others. My car is a 6 h.-p. belt driven, tonneau body, with hood, weighing 15 cwt. unladen, propelled by a horizontal petrol engine, and running on solid tyres; price, 285*l.* complete. The belt has been no trouble, and does not slip. Maximum speed on good road, a mile in $2\frac{1}{2}$–3 minutes. I have now had the car sixteen months, and have kept most careful accounts, which include every half-penny of expenditure. The details of expenses for the first twelve months are given below. Total distance travelled in twelve months, 3,450 miles.

	£	*s.*	*d.*
Petrol	10	19	4
Lubricating oil, grease, &c.	3	11	6
Charging accumulators	0	17	6
Pair of accumulators	3	15	0
Materials used in repairs, cleaning, &c.	1	19	5
Repairs and spare parts	14	12	3
Repairs necessitated by ignorance or collision	4	5	4
Liveries, &c.	11	2	5
Tools	5	3	6
Spare parts not used	7	0	6
Alterations and additions not necessary	22	7	0
Insurance premiums	3	16	6
Total running expenses	89	10	3

This does not include my man's wages.

The conclusions I draw from my experience are:—

Cost.—My motor costs more to keep up than one horse, the cost being probably equal to keeping a stable of two horses in the country.

Work.—The car has done quite double the work which it would be possible to get out of one horse. The amount, however, it is capable of doing is almost unlimited.

Pace.—It is faster than a horse, especially on long journeys.

Tyres.—In my opinion a car weighing over 10 cwt., fitted with pneumatic tyres, is not desirable for a medical man. With regard, however, to cars under 10 cwt., fitted with pneumatics, I do not feel in a position to give an opinion.

Weight.—A small light car is, I should imagine, more suitable for a medical man. This, however, practically necessitates pneumatic tyres.

The advantages of a small and light car are—(*a*) it takes less time to clean; (*b*) it is faster on heavy roads; (*c*) it costs less to run and keep up. The only disadvantage, in my opinion, is that no small light car is at present made, as far as I know, to run on solid tyres.

Horse-power.—It ought not to be less than 6 h.-p. nor more than 10 h.-p.

Shelter.—Some means of shelter from the weather is necessary, either in the form of a glass front and hood or canopy or a brougham top.

Man.—It is absolutely necessary to keep a man to clean and look after the car. I do not, however, advise a skilled engineer, as an intelligent groom or coachman can soon learn to look after it, but under these circumstances one must understand the mechanism oneself.

Reliability.—A car may break down oftener than a horse, but it is never, under any ordinary circumstances, laid up for weeks together. Most ordinary repairs can be done in a few hours.

I am not an enthusiastic advocate of cars for medical men, for they have their disadvantages. The advantages, however, in my opinion, outweigh the disadvantages, and I do not intend myself going back to a horse.

Here is another letter from a Doctor, which appeared in 'The Motor' in March, 1904.

UPKEEP OF LIGHT CARS:—Sir, In reply to your correspondent 'Forward,' I have been running a two-seated 6½ h.-p. car, weighing

$8\frac{1}{2}$ cwt., daily for eight months, except during my three weeks' holiday abroad and a period of ten days spent in retreading tyres. My mileage is 2,400. I work a medical practice in London. I have kept an account of every penny spent on the car, and find the total is 58*l.* 11*s.* 3*d.*, made up as follows :—Rent, 8*l.* 15*s.* ; boy, 12*l.* 5*s.* ; three accumulators, 3*l.* 6*s.* ; auto-trembler, wipe contact, and fitting on of same, 3*l.* 5*s.* 6*d.* ; retreading front tyres, 3*l.* 15*s.* ; carriage licenses, May 1903 and January 1904, 4*l.* 4*s.* ; registration and driver's license, 1904, 1*l.* 5*s.* ; number plates and tail lamp, 1*l.* ; voltmeter, 18*s.* 6*d.* ; extra expenses incurred when learning to drive, May 1903, 1*l.* 10*s.* ; petrol, 5*l.* 15*s.* ; repairs, 7*l.* 12*s.* 6*d.* ; oils, greases, sparking plugs, sponges, chamois, enamels, aluminium, paraffin (for cleaning, &c.), and small tools, 4*l.* 19*s.* 9*d.* I do all small adjustments now, and supervise cleaning, oiling, &c., which would otherwise be done indifferently by boys ; but the owner who uses a car daily and does everything himself will require to spend at least one hour a day in cleaning, oiling, and adjusting. My car is in very good condition at present, but will require to have back tyres retreaded before the summer. As I have got over the novitiate stage, and take a greater interest in seeing that all the parts are properly adjusted, instead of trusting to luck on the road, I expect to have a smaller bill for repairs this year. The fact that the car can be trusted to take me on my visiting rounds is of far greater importance than the actual mileage. A car that you can take out day after day at any given time and run for a round of about ten miles, stopping and starting from twelve to twenty times in this short journey, the greater part of which is through densely crowded traffic, may justly be called a reliable car. In my opinion, this work puts far more strain on the engine and transmission gear than treble the distance on top speed. It is amusing to me to hear people ask what is the cost of petrol. This is a mere trifle in the cost of running a car. Keep your car clean, especially the machinery part. Use oils and greases freely ; above all, keep your working parts scrupulously adjusted, and worry and the cost of carelessness will disappear.—Yours faithfully,

'DOCTOR.'

The Scottish Automobile Club recently had a discussion upon the cost, care, and upkeep of an autocar, when a member submitted the following interesting figures concerning the cost of running his 10 h.-p. car for 7,065 miles :—

	£	s.	d.	
Light, oils, and grease . .	3	5	$6\frac{1}{2}$	·11*d.* per mile.
Petrol	22	12	8	·77 ,,
Repairs and replacements .	12	9	11	·48 ,,
Tyres	27	15	3	·86 ,,
Sundries, licence, stabling and washing . . .	14	10	$11\frac{1}{2}$	·56 ,,
	80	14	4	2·78 ,,

Another member submitted the cost of running his 12 h.-p. car, which worked out as follows :—

	d.	
Petrol	·760	per mile
Oil	·066	,,
Grease	·033	,,
Electric current	·016	,,
Tyres (pneumatic)	1·332	,,
Repairs and sundries	·212	,,
Stabling, washing, and licence . . .	·417	,,
	2·836	,,

These results were based on an experience of 5,000 miles.

The cost of the Inland Revenue licence, mechanic's licence, wages, food and clothes, insurances, rent of coach house, and the sum which should be allowed annually for depreciation are not included in many of the tables given. It will be apparent from the foregoing matter that it is impossible to lay down any hard and fast rule as to what would be the cost of running a motor vehicle. The experiences of owners of various cars will, however, enable the reader to form an opinion for himself as to what will be the cost of running the car which he may select, provided that it be made by a reputable firm and that he is not foolish enough to have chosen a type which has never proved itself in any extended official trial, or provided the car be similar to one which after at least two years' work has proved satisfactory to a disinterested friend or trustworthy acquaintance.

CHAPTER XXIII

THE GORDON-BENNETT RACE OF 1903

By Julian W. Orde
(*Club Secretary, Automobile Club of Great Britain and Ireland*)

According to the rules of the Gordon-Bennett Cup, the race must take place in the country of the club holding the trophy, or in France if a suitable course be not available. As the Automobile Club of Great Britain and Ireland, represented by Mr. S. F. Edge on a Napier car, won the Cup in 1902, it became necessary that the race for 1903 should be held either in the British Isles or in France. After considering many suggestions, it was decided to hold the race in Ireland, provided the necessary authorisation to do so could be obtained from Parliament.

The Club contemplated organising an automobile tour through Ireland after the race, and particulars of the proposed course and of the subsequent tour were sent to a large number of influential persons and to some six hundred newspapers. The draft proposals were also laid before lieutenants of the Irish Counties, the County Councils, Borough Councils, Urban District Councils, Town Commissioners, &c. The attention of hotel proprietors and of the various railway and steamship companies was drawn to the great advantages which would accrue to Irish trade if the Gordon-Bennett race could be held in that country. Numerous favourable replies were received to these communications and also promises of support.

Resolutions in favour of holding the race were passed by the County Councils throughout Ireland, and later a monster

petition was signed by all classes and presented to Parliament in favour of a special Bill being passed to empower the Irish authorities to close the public roads over which it was proposed to run the race. On February 24 the first reading of the Bill was moved by Mr. John Scott Montagu in the House of Commons, and with the exception of a trivial hitch it went through all stages very rapidly. In the House of Lords the Bill was entrusted to Lord Londonderry, and it was passed by the Upper House also without delay.

The route chosen for the race passed through the counties of Kildare, Queens, and Carlow. The complete circuit measured 103 miles, and roughly speaking, it ran in the shape of the figure 8. To provide for the public safety was a matter of grave consideration, the importance of which was brought vividly forward by the ghastly failure of the Paris-Madrid automobile race during May. After conferring with the Committee of the Club the Local Government Board of Ireland issued a set of very complete regulations. In order that the public might be fully warned of the dangerous consequences of encroaching upon the road during the race, notices were posted in conspicuous positions all along the route and in the adjoining market towns. The local inhabitants were also circularised and requested to co-operate with the organisers of the event in guarding against accidents.

To ensure safety to the spectators as well as to the drivers over such a long course, a large force of police under the command of the inspector-general of the Royal Irish Constabulary, Colonel Sir Neville Chamberlain, K.C.B., were present, and some two thousand soldiers forming the camp at the Curragh were on duty under the command of Major-General Sir G. de C. Morton, K.C.I.E., C.V.O., C.B. Many willing volunteers, members of the Club and others, gave their services as road stewards and performed invaluable services in the 'controls' and at various other points of the route. A large number of motor cyclists also rendered assistance as despatch-riders; they were divided into separate corps under

'captains,' and were stationed at all important points. Their duties were often laborious, for in conveying their despatches they had to traverse bye-roads with which many of them were quite unacquainted.

Wire fences were erected across all roads converging upon the course (numbering about 270), in order that no stray cattle or horses could by any possible chance wander into the highway and so endanger the life of the competitors. Where possible, motor-cars belonging to members of the Club were also drawn up across the converging roads as an additional precaution.

The four competing Clubs were represented as follows :—

The A.C.G.B. & I. : Three Napier cars, driven by Messrs. S. F. Edge, Charles Jarrott, and J. W. Stocks.

The A.C. of France : Two Panhards and one Mors car, driven respectively by the Chevalier Rene de Knyff, Henri Farman, and Gabriel.

The A.C. of America : Two Winton and one Peerless cars, driven by Messrs. Alexander Winton, Percy Owen, and L. P. Mooers.

The A.C. of Germany : Three Mercédès cars, driven by Baron de Caters, Mr. Foxhall Keene, and Mr. Camille Jenatzy.

On the day before the race, namely July 1, the twelve competing cars were inspected and weighed at the town of Naas, the county town of Kildare. Several of the cars were found to be over the weight limit of 1,000 kilograms (or just under one ton), and these had to be stripped of everything not absolutely essential, in order to bring them within the regulation. It was a curious sight to see to what straits some of the competitors were brought in endeavouring to reduce the weight of their vehicles, every minute particle of unnecessary material being removed in the process.

The race was run on July 2, 1903, and thanks to the Local Government Board's regulations, the roads were, on that day, to all intents and purposes the private property of the A.C.G.B. & I.

The order of starting had been arranged as follows:—

A.C.G.B. & I.:	(1) Edge.	(5) Jarrott.	(9) Stocks.
A.C. of France:	(2) De Knyff.	(6) Gabriel.	(10) Farman.
A.C. of America:	(3) Owen.	(7) Mooers.	(11) Winton.
A.C. of Germany:	(4) Jenatzy.	(8) De Caters.	(12) Keene.

Before the race started, two pilot cars were sent round the course as a warning that the racers would follow shortly, but by a mistake they both followed the western circuit and thus the eastern circuit did not know that the race had begun until the actual competitors appeared. Mr. S. F. Edge was started off at 7 A.M., and the others followed at intervals of seven minutes. In order that very high rates of speed should be avoided in populous places where danger might be expected, nine 'controls' were established on the course. Upon reaching a control each car had to stop and proceed over a measured portion of the road at a low speed, an allowance being made in the final reckoning for the time thus lost.

The eventual result of the race is given on page 430.

It will be noticed that in the first time round, the Napier car covered the eastern, or shorter, circuit in the fastest time, and that the Mors car covered the western, or longer, circuit in the first round in less time than any of the other vehicles; but the great consistency with which the winning car accomplished the circle of the western circuit is also worthy of note.

Mr. Winton, who started eleventh, was in trouble at once, through the choking of the spray tube of his carburetter, and was delayed for about an hour at the starting-point.

The English competitors were remarkably unfortunate. Stocks on his first round over the eastern circuit met with an accident through mistaking the road, his car ran into one of the wire fences previously mentioned which became so entangled with the vehicle that it was too damaged to continue, and thus Stocks was early out of the race. Jarrott unluckily came to grief through his steering-gear snapping and causing the car to turn over, but fortunately he escaped serious injury.

When this mishap took place, wild rumours spread around the course to the effect that a terrible smash-up had occurred.

GORDON-BENNETT CUP RACE, 1903

Net Time of Circuits and Total (excluding Controls)

	Country	Driver	Make of Car	Circuit No. 1	Circuit No. 2	Circuit No. 3	Circuit No. 4	Circuit No. 5	Circuit No. 6	Circuit No. 7	Net total	Average miles per hour
				h. m. s.	h. m. s.	h. m. s.	h. m. s.	h. m. s.	h m. s.	h. m. s.	h. m. s.	
1st	Germany	M. Jenatzy	Mercédès	— 48 58	1 1 19	— 49 45	1 · 1 52	— 53 16	1 1 32	1 2 18	6 39 —	49·25
2nd	France	De Knyff	Panhard	— 49 47	1 2 31	— 50 57	1 8 16	— 51 40	1 3 39	1 3 50	6 50 40	47·85
3rd	France	H. Farman	Panhard	— 47 31	1 10 27	— 49 35	1 5 55	— 50 31	1 2 17	1 5 28	6 51 44	47·72
4th	France	Gabriel	Mors	— 53 10	1 0 19	1 2 37	1 4 20	— 51 4	1 13 58	1 6 5	7 11 33	45·33
	England	S. F. Edge	Napier	— 46 23	1 7 3	1 27 59	1 24 59	1 14 35	1 55 21	1 22 28	9 18 48	35·16

Length of circuits, excluding controls: 1, 3, and 5, 40 miles; 2, 4, 6, 7, $51\frac{7}{8}$ miles.

It was at this point that Baron de Caters behaved in such a chivalrous manner. Knowing that the spectators on the Club grand stand would be feeling anxious about Jarrott, he actually stopped his car to state that although the vehicle was smashed the driver was not seriously injured. When one considers the keen excitement of the race and realises the importance of every second lost, the sportsmanlike action of Baron de Caters can be appreciated. These unfortunate accidents left England with only one representative at a comparatively early stage.

Edge was, however, also in difficulties, as will be seen by reference to the times of the several cars quoted above, the chief trouble apparently being the difficulty of keeping the tyres on the back wheels of the car, owing to the enormous power developed and the high speed at which it travelled. Later, a Mercédès car, driven by Mr. Foxhall Keene, had to retire on account of the rear axle breaking, and for a similar cause the car driven by Baron de Caters had subsequently to be withdrawn.

The American cars made a very poor show, and went out one by one at various stages. It is safe to say that the industry is in its infancy in the United States, at all events as far as racing machines are concerned. As a result of the race the competitors must have realised that a car, the highest speed of which is fifty miles per hour on the level, is of no use for the purpose of a long road race; for it is obvious that a much higher speed is necessary in order even to remain 'in the running.' One of the strongest points in connection with the Mercédès cars which told so much in their favour was the ease with which they could be started, and the smooth manner in which the gears worked.

The Lord-Lieutenant of Ireland, the Earl of Dudley, took considerable interest in the arrangements for the race, and did a great deal towards the successful carrying out of the proposal for it to be run in Ireland; and there can be no doubt that it did much good for the country, for many thousand pounds were spent there which otherwise would probably have been spent in France.

APPENDIX

RACES AND TRIALS

By C. L. Freeston

Only under the stress of competition are the weak points of a motor-car most strikingly revealed, and, per contra, its strong ones emphasised. Whatever opinions may be held as to the propriety of continuing the Continental races now that cars are capable of tremendous speeds, there is no gainsaying the fact that, without the influence which the early competitions in France exerted upon the public mind, and the lessons learned by makers themselves from the success or non-success of particular vehicles, the industry in France would not have arrived at the position it now holds ; nor, for that matter, would the English or German cars have attained their present degree of mechanical excellence.

Even with the aid of racing, however, the development of the motor-car has been a matter of slow growth, and by many new recruits to the pastime it may be learned with surprise that a competition was held in France so long ago as 1894, from Paris to Rouen, when the cars of Panhard et Levassor and Peugeot Frères shared the leading honours, with motors of 3½ h.-p. The times are not recorded. It was not until June 1895, however, that the foundation of a series of classic events was laid by a race from Paris to Bordeaux and back, 732 miles, when a 3½-h.-p. Panhard et Levassor car accomplished the journey in 48 h. 48 m. at the rate of nearly fifteen miles per hour. The good effects of racing have been abundantly displayed since that memorable event, for even M. Panhard himself was satisfied with the results, and progress might have been stayed for an indefinite period but for the stimulus of competition. The story is vouched for that at a banquet following this event an enthusiastic, yet prescient, speaker expressed the belief that the journey to Bordeaux would eventually be covered not at fifteen, but at fifty, miles an hour. Thereupon M. Panhard leaned over to the chairman, the Baron de

Zuylen, and whispered a regret that on such occasions there was 'always one person who made an ass of himself.' Only six years later the course was covered at an even higher rate than was predicted by the after-dinner prophet, and, among others, by Panhard cars, though the founder of the firm unfortunately did not live to witness this startling consummation.

In September 1896, a race was held from Paris to Marseilles and back (1,061 miles), and two 4-h.-p. Panhard cars completed the course at the average speed of 15·65 and 15·55 miles an hour respectively, with four passengers, as against the two of the Bordeaux race. More definite progress, moreover, was soon to be recorded, for on July 24, 1897, a race was run from Paris to Dieppe (106 miles), and was won by a 6-h.-p. Panhard in 4 h. 36 m., or 23·1 miles an hour. On July 7, 1898, an 8-h.-p. Panhard averaged 29 miles an hour in a race of 895 miles from Paris to Amsterdam and back, and by the next year the 12-h.-p. car had appeared upon the scene, the Paris-Bordeaux race being won by a Panhard of that power in 11 h. 43 m. 29 s., or 33·30 miles an hour.

The year 1899 also witnessed the great 'Tour de France,' a race of no less a distance than 1,440 miles, which was won by a 16-h.-p. Panhard, driven by de Knyff in 44 h. 59 m., or 31·9 miles an hour. The interesting fact may here be stated that in every race yet mentioned the first three cars were all Panhards, and the fourth was invariably a Peugeot, up to the 'Tour de France,' when a Bollée stepped into the place. The Mors vehicle, however, now proved a formidable rival to the Panhard. In the Paris-St. Malo race two 16-h.-p. cars of that make came in first and second, driven by Antony and Levegh, in 7 h. 32 m. and 7 h. 40 m. respectively, over a distance of 226 miles. In the Paris-Ostend race (201 miles) Levegh on a 16-h.-p. Mors, and Girardot on a 12-h.-p. Panhard, made a dead heat of it, their time being 6 h. 11 m., or 32½ miles an hour. Girardot, however, won the Paris-Boulogne race (143 miles) in 4 h. 17 m. 44 s.; Levegh's time was 4 h. 19 m. 20 s., the winner's speed being 33⅓ miles an hour. A subsequent race from Bordeaux to Bayonne (163 miles) was won by Levegh in 4 h. 24 m.

In 1900 the 'Circuit du Sud-Ouest' race, from Pau over a course of 208 miles, was won by de Knyff, who made the astonishing time of 4 h. 46 m. 57 s., averaging 43½ miles an hour, and being credited on one stage with 34 miles in 33½ minutes. He drove a 16-h.-p.

Panhard. No other competitor came anywhere near de Knyff's time; the Comte Bozon de Périgord was second in 5 h. 33 m. $52\frac{2}{5}$ s.

The Nice to Marseilles race was won by de Knyff on a Panhard, at an average rate of 36·6 miles per hour for the 125 miles, two other Panhards being close up. Levegh, however, on a Mors, won the La Turbie hill-climbing race ($10\frac{1}{2}$ miles) at 33·1 miles per hour, the mile race at $36\frac{1}{2}$ miles per hour, and the flying kilometre at $46\frac{1}{2}$ miles per hour.

Levegh did another remarkable performance in the Bordeaux-Périgueux-Bordeaux race ($195\frac{1}{2}$ miles), covering the distance in 4 h. 1 m. 45 s. The first stage of this race (72 miles) was accomplished in 1 h. 24 m. 35 s., equal to 51 miles an hour.

An exceedingly unfortunate race was that from Paris to Toulouse and back; it was run in three stages during a heat wave, and tyre troubles were numerous. Levegh on his Mors covered the distance of 838·08 miles, excluding controls, in 20 h. 50 m. 9 s., an average of 40 miles an hour. Pinson was second in 22 h. 11 m. 1 s., and Voigt third in 22 h. 11 m. 51 s., each driving a Panhard.

The Pau meeting of 1901 produced a good performance by Maurice Farman, who won the Grand Prix de Pau race (205 miles) in 4 h. 28 m. 20 s. on a 24-h.-p. Panhard, thus averaging 46 miles per hour.

At Nice the Nice-Salon-Nice race (244 miles without controls) was won by Baron Henri de Rothschild (35-h.-p. Mercédès) in 6 h. 45 m. 48 s. In the Coupe de Rothschild flying kilometre, a Serpollet car made the remarkable time of $35\frac{4}{5}$ seconds, or $62\frac{2}{3}$ miles per hour. Four Mercédès cars came next in order, the best time being $41\frac{4}{5}$ seconds. In the La Turbie hill-climb the fastest car was Baron de Rothschild's Mercédès, its time being 18 m. $6\frac{4}{5}$ s., or $31\frac{1}{8}$ miles per hour. The Serpollet's time was 24 m. $11\frac{3}{5}$ s.

The Paris-Bordeaux race was won by Fournier on a Mors of 60 b.-h.-p., in the splendid time of 6 h. 10 m. 44 s., an average of 53 miles an hour. Maurice Farman, on a Panhard, was second in 6 h. 41 m. 15 s.; and Voigt third in 7 h. 15 m. 11. s.

A still greater event was the Paris-Berlin race, which attracted the attention of the entire Continent. Fournier repeated his previous success, winning in the net time of 16 h. 5 m., Girardot being second in 17 h. 7 m., de Knyff third in 17 h. 11 m., and Brasier fourth in 17 h. 42 m. The distance, excluding controls, was 749 miles, Fournier thus averaging $46\frac{1}{2}$ miles an hour over the three days' course.

At the Nice meeting in April, 1902, the fastest time in the La Turbie Hill Climb was made by Mr. Stead on a 40 h.-p. Mercédès,

the course of $15\frac{1}{2}$ kilometres being covered in a thick fog in 16 m. $37\frac{3}{5}$ s. M. Serpollet covered the flying kilometre on the promenade in $29\frac{4}{5}$ s., or at the rate of over 75 miles an hour.

An Alcohol race over the Circuit du Nord was brought off on May 15 and 16, the course being $572\frac{1}{2}$ miles. The winner was Maurice Farman on a 35 h.-p. Panhard, his time being 12 h. 2 m. $1\frac{4}{5}$ s., or 47·4 miles per hour. Marcellin on a 20 h.-p. Darracq was second, with an average of 41·2 miles per hour.

The greatest road race yet run, namely, that from Paris to Vienna, took place on June 26–28, the total course being $615\frac{1}{2}$ miles. Out of 137 starters 80 reached Vienna. In the heavy car class the winner was H. Farman on a 70 h.-p. Panhard, his time being 16 h. 0 m. $30\frac{1}{5}$ s., or 38·7 miles an hour. In the light car class, however, Marcel Renault finished in 15 h. 47 m. $43\frac{4}{5}$ s.

The Circuit des Ardennes Race on July 31, over a 318 miles course, produced a fine race which was won by C. Jarrott on a 70 h.-p. Panhard in 5 h. 53 m. 39 s., or $54\frac{1}{2}$ miles an hour; Gabriel being second on a 70 h.-p. Mors in 6 h. 2 m. 25 s., or $53\frac{1}{2}$ miles an hour.

A record was set up on the Dourdan route by Augières, on a Mors, of 46 s. for the flying mile, or 78·21 miles an hour.

At the 'Nice week' of 1903 Braun, with a 60 h.-p. Mercédès, covered the standing mile in 1 m. 3·72 s., or 57 miles an hour. The Rothschild Cup No. 1. was won by M. Serpollet in 29 m. 19 s. for the flying kilometre, or 76·75 miles an hour. Hieronymus, on a 60 h.-p. Mercédès, won the Rothschild Cup No 2. in 31 m. 76 s., or 70·35 miles an hour.

On May 21 was started the first stage of the Paris-Madrid race, from Versailles to Bordeaux. The best times were as follows: Gabriel (70 h.-p. Mors), 5 h. 13 m. 31 s.; Louis Renault (Renault), 5 h. 39 m. 59 s.; Salleron (70 h.-p. Mors), 5 h. 46 m. 1 s.; Jarrott (45 h.-p. Diétrich), 5 h. 51 m. 55 s.; Warden (60 h.-p. Mercédès), 5 h. 56 m. $30\frac{4}{5}$ s. Gabriel's average pace was $65\frac{1}{2}$ miles an hour, although he had to pass nearly 80 other cars. Owing to the number of accidents the race was not continued to Madrid.

The Circuit des Ardennes race on June 22 and 23 was run over a course of 315 miles. Baron Pierre de Crawhez, on a 70 h.-p. Panhard, was first in 5 h. 52 m. $7\frac{3}{5}$ s., or $53\frac{3}{4}$ miles an hour, Girardot being second on a 'C.G.V.' in 6 h. 12 m. $11\frac{4}{5}$ s., and Baron de Brou third on a De Diétrich in 6 h. 24 m.

At the Nice week of 1904 the two Rothschild Cups were won by Rigolly on a 112 h.-p. Gobron-Brillié in 24 s. and $23\frac{3}{5}$ s. respectively for the flying kilometre.

Of a very different character from these magnificent displays of physical endurance and mechanical speed, but interesting, nevertheless, from many points of view, have been the various trials conducted by the Automobile Club of Great Britain and Ireland. Of necessity they have been tests of efficiency, pure and simple; the Club has never held a road-race of any description, and its only speed tests on the flat have been on a private road in Welbeck Park. Sundry hill-climbing competitions have been held on the public highway, but in cases where a powerful car has been able to exceed the legal limit of speed, such excess has not been officially recorded. The Club has also held petroleum spirit trials, brake trials, and non-stop runs of 100 miles, in addition to the Thousand Miles Trial of 1900 and the 'Glasgow Week' in 1901.

The first important trials of the Club were in connection with the Richmond Show in 1899, when a number of cars competed in the ascent of Petersham Hill, the maximum gradient of which is 1 in 9·43. Few of the cars of that date could do much better than five miles an hour, but the 8-h.-p. Panhard driven by the Hon. C. S. Rolls ascended at 8¾ miles per hour. It also made a non-stop run of fifty miles on the Oxford Road. Other non-stop journeys were made by a 5½-h.-p. Daimler, two Benz cars, a Lanchester phaeton, a Delahaye, a Motor Manufacturing, and a Hercules car respectively.

The great Thousand Miles Trial of 1900 extended from April 23 to May 12. No fewer than sixty-five vehicles started, the majority of which completed the course. The following maintained a speed of not less than the legal limit throughout:—Section I. (Manufacturers):—Gladiator, de Dion and Wolseley voiturettes, Motor Manufacturing Iveagh, 6-h.-p. Daimler, Ariel quadricycle, and Ariel tricycle with trailer. Section II. (Private Owners):—6-h.-p. Panhard (Mr. T. B. Browne), 8-h.-p. Napier (Mr. E. Kennard), 12-h.-p. Daimler (Hon. J. Scott Montagu, M.P.), 12-h.-p. Panhard (Hon. C. S. Rolls), and 12-h.-p. Daimler (Mr. J. A. Holder).

In a speed trial at Welbeck Park the following were the best times for the mean of two tests over a mile course:—Mr. Rolls's 12-h.-p. Panhard, 37·63 miles per hour; Mr. Kennard's 8-h.-p. Napier, 29·6; Mr. Mark Mayhew's 8-h.-p. Panhard, 29·6; Ariel tricycle with trailer, 29·45; Mr. Holder's Daimler, 26·23.

Four hill-climbing competitions were held during the trial. At Taddington the following ascended at 12 miles per hour or over:

Ariel tricyle (Mr. A. J. Wilson), 12-h.p. Panhard (Hon. C. S. Rolls), Ariel quadricycle, Ariel tricycle with trailer, 8-h.-p. Napier (Mr. E. Kennard), and 12-h.-p. Daimler (Mr. J. A. Holder). At the steep portion of Shap Fell the Empress tricycle and Mr. Rolls's Panhard were the most successful. On Dunmail Raise the Napier, Empress tricycle, and Mr. Rolls's Panhard were 'up to the limit,' while on Birkhill the Ariel quadricycle, Ariel tricycle with trailer, Enfield quadricycle, and Mr. Rolls's Panhard achieved the same result. Numerous prizes were awarded at the conclusion of the trials, the gold medal for the best car in any class being bestowed on Mr. Rolls's Panhard.

Less ambitious in respect of distance, but more practical in other ways, were the Glasgow Trials of September 2 to 6, 1901. Every car had an official observer throughout, so that each stoppage was recorded, save those for punctures. The following cars gained the daily maximum possible of 300 marks :—Class A (250*l.* or under), Argyll voiturette ; Class C (350*l.* to 500*l.*), 8-h.-p. Arrol-Johnston ; Class D (over 500*l.*), 9-h.-p. Napier. A considerable number of other cars came very near the maximum. In the compulsory hill-climbing trials at Fintry and Gleneagles the highest awards of marks were as follows :—Section I., Class A, 7-h.-p. New Orleans, 341 marks ; Class B (250*l.* to 350*l.*), 6-h.-p. M.M.C., 183 marks ; Class C, M.C.C. 6-seated car, 321 marks ; Class D, 16-h.-p. Milnes, 159 marks. Section II., Mr. William Exe's 7-h.-p. New Orleans, 349 marks. The highest totals in respect of trustworthiness and hill-climbing were as follows :—Section I., Class A, 7-h.-p. New Orleans, 1,807 marks ; Class B, 6-h.-p. M.M.C., 1,675 ; Class C, M.M.C. car, 1,814 ; Class D, 16-h.-p. Milnes, 1,657. Section II., Mr. Willam Exe's New Orleans, 1,836.

Other points as to which no marks were published, were taken into consideration by the judges, and the gold medals were awarded to two Wolseley cars, a Locomobile, a 16 h.-p. Milnes, and a 6-h.-p. M.M.C. delivery van.

A petroleum spirit trial was held on April 13, 1901, over a thirty-mile course from Sheen House, on a very unfavourable day for economical consumption. The best record was one of 7·9 pints by a 6-h.-p. New Orleans car, a 7-h.-p. New Orleans coming next with one gallon.

Another consumption trial took place on May 2, 1901, at Dashwood Hill, combined with a hill-climbing trial and a non-stop run of 31 miles each way between London and the foot of the hill.

The hill was ascended seven times by each car, these representing a distance of four miles in all and a rise of 1,470 feet. The most economical consumption record was that of a 7-h.-p. New Orleans with 1·03 gallon for the outward journey, ·33 gallon on the hill, and ·875 gallon in returning to town. As regards the ascent, the Hon. J. Scott Montagu's 24-h.-p. car and Mr. J. R. Hargreaves's 19-h.-p. Daimler were up to the legal limit, while the 7-h.-p. New Orleans did 10·36 miles per hour. Non-stop runs were made on both journeys by the 8½-h.-p. Decauville, 7-h.-p. New Orleans, 6-h.-p. Daimler, 5-h.-p. Wolseley, and 3-h.-p. Ariel quadricycle.

Another hill-climbing trial, open to all comers, was held at Dashwood Hill on July 6, 1901. Each vehicle was required to ascend three times, with a full load of passengers weighing not less than 10½ stones each. The following cars ascended 'up to the legal limit':—50-h.-p. Napier, 16-h.-p. Daimler, and 12-h.-p. Chainless in the petrol-driven class, and the Locomobile and Weston steam-cars also. On the premise, however, that the best vehicle is the one which at the lowest purchase price can convey the greatest number of passengers at the highest speed, the Trials Committee awarded the Chainless the highest marks, a 7-h.-p. Panhard coming second, and a 4½-h.-p. Renault third, the times of the latter two being 10 and 6·3 miles per hour respectively. In the steam class the Locomobile was placed first.

In the quarterly 100 miles competitions initiated in November 1899, the following vehicles have made the journey without a stop:—3-h.-p. Benz, 5½-h.-p. Daimler, 16-h.-p. Milnes, 6-h.-p. Simms, 2¼-h.-p. Beeston tricycle, 5-h.-p. Peugeot, 12-h.-p. Gladiator, 9-h.-p. Earl, 12-h.-p. Herald, 22-h.-p. Rochet-Schneider, 12-h.-p. Boyer, 14-h.-p. Brooke, 6-h.-p. Siddeley, and 5-h.-p. Beeston Humberette.

Mention must not be omitted of the interesting brake trials at Welbeck Park in January 1902, with the object of providing trustworthy data for the instruction of the Local Government Board, whose chief engineering inspector was present. After systematic experiments, officially timed and measured, the following were found to be the distances within which cars could be brought to a standstill:—

From 11 to 14 miles per hour in 1⅘ time the car's length;
From 15 to 17 miles per hour in twice the car's length;
From 18 to 20 miles per hour in 2¾ times the car's length;
From 20 to 24 miles per hour in 3½ times the car's length.

On April 16 and 17, 1902, a non-stop trial was held from Glasgow to London. Six cars and two tandems started, and marks were awarded as follows to the three cars which finished:—8-h.-p. De Dion, 86 marks; 8-h.-p. M.M.C., 74 marks; and 16-h.-p. Napier, 68 marks.

In September, a Reliability Trial of 650 miles extending over six days was held over routes radiating from the Crystal Palace. The following vehicles were awarded Gold Medals:—Class A., 3-h.-p. Humber bicycle; Class B., two $5\frac{1}{2}$-h.-p. Locomobiles; Class C., 8-h.-p. M.M.C.; Class D., 10-h.-p. Wolseley; Class F., 10-h.-p. Peugeot; Class G., 20-h.-p. Wolseley; Class J., 20-h.-p. Pascal; Class K., 15-h.-p. Panhard. The following received Silver Medals:—Class A., 5-h.-p. Century Tandem; Class C., 6-h.-p. De Dion and 6-h.-p. White; Class D., 8-h.-p. De Dion; Class E., $7\frac{1}{2}$-h.-p. Germain; Class F., 6-h.-p. Gardner-Serpollet; Class G., 15-h.-p. Germain; Class H., 12-h.-p. Germain; Class J., 20-h.-p. Maudslay; Class K., 22-h.-p. Daimler.

A Four Thousand Miles Tyre Trial was also held in September and October, and lasted six weeks. The first prize of 100*l.* was awarded to the Dunlop Pneumatic Tyre Co.; the second prize of 50*l.* fell to the Collier Tyre Co; while the third prizes of 10*l.* each were awarded to the Dunlop Co. and the Maison-Talbot Syndicate.

The Glasgow to London Non-Stop Trial of May 1903 showed excellent results. The maximum number of marks were earned by two 12-h.-p. Sunbeams, two 12-h.-p. Arrol-Johnstons, a 10-h.-p. Lanchester, a 10-h.-p. Wolseley, and a 12-h.-p. Argyll, while nine other competitors earned over 990 marks out of a thousand.

Over a hundred vehicles competed in the Reliability Trials of September 1903, in eight daily runs totalling 1,019 miles. Gold Medals were awarded as follows:—Class A., 5-h.-p. Oldsmobile; Class B., 8-h.-p. M.M.C.; Class C., 10-h.-p. Gladiator; Class D., 12-h.-p. New Orleans; Class E., 10-h.-p. Gardner-Serpollet and 14-h.-p. Martini; Class F., 16-h.-p. Rochet-Schneider; Class G., 22-b.-h.-p. Daimler. The following received Silver Medals:—Class A1, 5-h.-p. Century Tandem; Class A., 6-h.-p. Oldsmobile; Class B., 6-h.-p. Swift; Class C., $7\frac{1}{2}$-h.-p. Wolseley; Class D., 12-h.-p. De Dion; Class F., 20-h.-p. M.M.C.

THE MOTOR LAWS AS THEY EXIST

THE LIGHT LOCOMOTIVES' ACT OF 1896

An Act to amend the Law with respect to the Use of Locomotives on Highways. [14th August 1896.]

BE it enacted by the Queen's most Excellent Majesty, by and with the advice and consent of the Lords Spiritual and Temporal, and Commons, in this present Parliament assembled, and by the authority of the same as follows :—

Exemption of Light Locomotives from Certain Statutory Provisions.—1.—(1.) The enactments mentioned in the schedule to this Act, and any other enactment restricting the use of locomotives on highways and contained in any public general or local and personal Act in force at the passing of this Act, shall not apply to any vehicle propelled by mechanical power if it is under three tons in weight unladen, and is not used for the purpose of drawing more than one vehicle (such vehicle with its locomotive not to exceed in weight unladen four tons), and is so constructed that no smoke or visible vapour is emitted therefrom except from any temporary or accidental cause; and vehicles so exempted, whether locomotives or drawn by locomotives, are in this Act referred to as light locomotives.

Provided that—

(*a*) the council of any county or county borough shall have power to make bye-laws preventing or restricting the use of such locomotives upon any bridge within their area, where such council are satisfied that such use would be attended with damage to the bridge or danger to the public:

(*b*) a light locomotive shall be deemed to be a carriage within the meaning of any Act of Parliament, whether public general or local, and of any rule, regulation, or byelaw, made under any Act of Parliament, and, if used as a carriage of any particular class, shall be deemed to be a carriage of that class, and the law relating to carriages of that class shall apply accordingly.

(2.) In calculating for the purposes of this Act the weight of a vehicle unladen, the weight of any water, fuel, or accumulators, used for the purpose of propulsion, shall not be included.

Regulation as to Lights.—2. During the period between one hour after sunset and one hour before sunrise, the person in charge of a light locomotive shall carry attached thereto a lamp so constructed and placed as to exhibit a light in accordance with the regulations to be made by the Local Government Board.

Locomotives to Carry a Bell.—3. Every light locomotive shall carry a bell or other instrument capable of giving audible and sufficient warning of the approach or position of the carriage.

Rate of Speed.—4. No light locomotive shall travel along a public highway at a greater speed than fourteen miles an hour, or than any less speed that may be prescribed by regulations of the Local Government Board.

Use of Petroleum, &c.—5. The keeping and use of petroleum or of any other inflammable liquid or fuel for the purpose of light locomotives shall be subject to regulations made by a Secretary of State, and regulations so made shall have effect notwithstanding anything in the Petroleum Acts, 1871 to 1881.

Local Government Board Regulations.—6.—(1.) The Local Government Board may make regulations with respect to the use of light locomotives on highways, and their construction, and the conditions under which they may be used.

(2.) Regulations under this section may, if the Local Government Board deem it necessary, be of a local nature and limited in their application to a particular area, and may, on the application of any local authority, prohibit or restrict the use of locomotives for purposes of traction in crowded streets, or in other places where such use may be attended with danger to the public.

All regulations under this section shall have full effect notwithstanding anything in any other Act, whether general or local, or any byelaws or regulations made thereunder.

Every regulation purporting to be made in pursuance of this section shall be forthwith laid before both Houses of Parliament.

Penalties.—7. A breach of any byelaw or regulation made under this Act, or of any provision of this Act, may, on summary conviction, be punished by a fine not exceeding ten pounds.

Excise Duty on Certain Locomotives.—8.—(1.) On and after the first day of January next after the passing of this Act there shall be granted, charged, and paid in Great Britain for every light locomotive, which is liable to duty either as a carriage or as a hackney carriage under section four of the Customs and Inland Revenue Act, 1888, an additional duty of excise at the following rate, namely—

	£	s.	d.
If the weight of the locomotive exceeds one ton unladen, but does not exceed two tons unladen	2	2	0
If the weight of the locomotive exceeds two tons unladen	3	3	0

(2.) Every such duty shall be paid together with the duty on the licence for the locomotive as a carriage or a hackney carriage, and shall in England be dealt with in manner directed with respect to duties on local taxation licences within the meaning of the Local Government Act, 1888 ; and in Scotland be paid into the Local Taxation (Scotland) Account, and be dealt with as part of the residue within the meaning of section two, sub-section (3), of the Local Taxation (Customs and Excise) Act, 1890.

Construction of Wheels of Locomotives on Roads.—9. The requirements of sub-section (4) of section twenty-eight of the Highways and Locomotives Amendment Act, 1878, may be from time to time varied by order of the Local Government Board.

Application to Scotland.—10. In the application of this Act to Scotland a reference to the Secretary for Scotland shall be substituted for a reference to the Local Government Board, a reference to the road authority of any county or burgh for a reference to the council of a county or county borough, and a reference to sub-section (4) of section three of the Locomotives Amendment (Scotland) Act, 1878, for a reference to sub-section (4) of section twenty-eight of the Highways and Locomotives Amendment Act, 1878.

Application to Ireland.—11. In the application of this Act to Ireland a reference to the Local Government Board for Ireland shall be substituted for a reference to the Local Government Board, and a reference to the council of a county shall be construed in an urban sanitary district under the Public Health (Ireland) Act, 1878, as a reference to the urban sanitary authority, and elsewhere as a reference to the grand jury.

Short Title and Commencement.—12. This Act may be cited as the Locomotives on Highways Act, 1896, and shall come into operation on the expiration of three months from the passing thereof.

THE FULL TEXT OF THE NEW ACT

An Act to amend the Locomotives on Highways Act, 1896. [14th August 1903.]

Be it enacted by the King's most Excellent Majesty, by and with the advice and consent of the Lords Spiritual and Temporal, and Commons, in this present Parliament assembled, and by the authority of the same as follows:—

Reckless Driving.—1.—(1.) If any person drives a motor car on a public highway recklessly or negligently, or at a speed or in a manner which is dangerous to the public, having regard to all the circumstances of the case, including the nature, condition, and use of the highway, and to the amount of traffic which actually is at the time, or which might reasonably be expected to be, on the highway, that person shall be guilty of an offence under this Act.

(2.) Any police constable may apprehend without warrant the driver of any car who commits an offence under this section within his view, if he refuses to give his name and address or produce his licence on demand, or if the motor car does not bear the mark or marks of identification.

(3.) If the driver of any car who commits an offence under this section refuses to give his name or address, or gives a false name or address, he shall be guilty of an offence under this Act, and it shall be the duty of the owner of the car, if required, to give any information which it is within his power to give, and which may lead to the identification and apprehension of the driver, and if the owner fails to do so he also shall be guilty of an offence under this Act.

Registration of Motor Cars.—2.—(1.) Every motor car shall be registered with the council of a county or county borough, and every such council shall assign a separate number to every car registered with them.

(2.) A mark indicating the registered number of the car and the council with which the car is registered shall be fixed on the car or on a vehicle drawn by the car, or on both, in such manner as the council require in conformity with regulations of the Local Government Board made under this Act.

(3.) A fee of twenty shillings shall be charged by the council of a county or county borough on the registration of a car, except in the case of motor cycles, for which the fee shall be five shillings.

(4.) If a car is used on a public highway without being registered, or if the mark to be fixed in accordance with this Act is not so fixed, or if, being so fixed, it is in any way obscured or rendered or allowed to become not easily distinguishable, the person driving the car shall be guilty of an offence under this Act, unless, in the case of a prosecution for obscuring a mark or rendering or allowing it to become not easily distinguishable, he proves that he has taken all steps reasonably practicable to prevent the mark being obscured or rendered not easily distinguishable

Provided that—

(*a*) A person shall not be liable to a penalty under this section if he proves that he has had no reasonable opportunity of registering the car in accordance with this section, and that the car is being driven on a highway for the purpose of being so registered; and

(*b*) The council of any county or county borough in which the business premises of any manufacturer of, or dealer in, motor cars are situated, may, on payment of such annual fee, not exceeding three pounds, as the council require, assign to that manufacturer or dealer a general identification mark which may be used for any car on trial after completion, or on trial by an intending purchaser, and a person shall not be liable to a penalty under this section while so using the car if the mark so assigned is fixed upon the car in the manner required by the council in accordance with regulations of the Local Government Board made under this Act.

Licensing of Drivers.—3.—(1.) A person shall not drive a motor car on a public highway unless he is licensed for the purpose under this section, and a person shall not employ any person who is not so licensed to drive a motor car.

If any person acts in contravention of this provision, he shall be guilty of an offence under this Act.

(2.) The council of a county or county borough shall grant a licence to drive a motor car to any person applying for it who resides in that county or county borough on payment of a fee of five shillings, unless the applicant is disqualified under the provisions of this Act.

(3.) A licence shall remain in force for a period of twelve months from the date on which it is granted, but shall be renewable, and the same provisions shall apply with respect to the renewal of the licence as apply with respect to the grant of the licence.

(4.) A licence must be produced by any person driving a motor car when demanded by a police constable. If any person fails so to produce his licence, he shall be liable, on summary conviction, in respect of each offence, to a fine not exceeding five pounds.

(5.) Any person under the age of seventeen years shall be disqualified for obtaining a licence (except that a licence limited to driving motor cycles may be granted to a person over the age of fourteen years), and any person who already holds a licence shall be disqualified for obtaining another licence while the licence so held by him is in force.

Suspension of Licence and Disqualification.—4.—(1.) Any court before whom a person is convicted of an offence under this Act, or of any offence in connection with the driving of a motor car, other than a first or second offence, consisting solely of exceeding any limit of speed fixed under this Act—

(*a*) may, if the person convicted holds any licence under this Act, suspend that licence for such time as the court thinks fit; and, if the court thinks fit, also declare the person convicted disqualified for obtaining a licence for such further time after the expiration of the licence as the court thinks fit; and

(*b*) may, if the person convicted does not hold any licence under this Act, declare him disqualified for obtaining a licence for such time as the court thinks fit; and

(*c*) if the person convicted holds any licence under this Act, shall cause particulars of the conviction, and of any order of the court made under this section, to be endorsed upon any licence held by him, and shall also cause a copy of those particulars to be sent to the council by whom any licence so endorsed has been granted.

(2.) Any person so convicted, if he holds any licence under this Act, shall produce the licence within a reasonable time, for the purposes of endorsement, and if he fails to do so shall be guilty of an offence under this Act.

(3.) A licence so suspended by the court shall during the term of suspension be of no effect, and a person whose licence is suspended or who is declared by the court to be disqualified for obtaining a licence shall during the period of suspension or disqualification be disqualified for obtaining a licence.

(4.) Any person who is by virtue of an order of the court under this section disqualified for obtaining a licence may appeal against the order in the same manner as a person may appeal who is ordered to be imprisoned without the option of a fine; and the court may, if they think fit, pending the appeal, defer the operation of the order.

(5.) If any person who, under the provisions of this Act is disqualified for obtaining a licence, applies for or obtains a licence while he is so disqualified, or if any person whose licence has been endorsed applies for or obtains a licence without giving particulars of the endorsement, that person shall be

guilty of an offence under this Act, and any licence so obtained shall be of no effect.

Forgery, &c., of Identification Mark or Licence.—5. If any person forges, or fraudulently alters or uses, or fraudulently lends or allows to be used by any other person, any mark for identifying a car or any licence under this Act, he shall be guilty of an offence under this Act.

Duty to Stop in Case of Accident.—6. A person driving a motor car shall, in any case, if an accident occurs to any person, whether on foot, or horseback, or in a vehicle, or to any horse or vehicle in charge of any person, owing to the presence of the motor car on the road, stop, and if required, give his name and address, and also the name and address of the owner and the registration mark or number of the car; and if any person knowingly acts in contravention of this section, he shall be liable, on summary conviction, in respect of the first offence to a fine not exceeding ten pounds, and in respect of the second offence to a fine not exceeding twenty pounds; and in respect of any subsequent offence to a fine not exceeding twenty pounds, or, in the discretion of the court, to a term of imprisonment not exceeding one month.

Regulations by Local Government Board, 59 and 60 Vict. c. 36.—7.—(1.) The Local Government Board may, under section six of the Locomotives on Highways Act, 1896 (in this Act referred to as the principal Act), make regulations—

(*a*) providing generally for facilitating the identification of motor cars, and in particular for determining, and regulating generally the size, shape and character of the identifying marks to be fixed under this Act, and the mode in which they are to be fixed and to be rendered easily distinguishable whether by night or by day, and with respect to the registration of cars, and the entry of particulars, including particulars of the ownership of the car, in the register, and the giving of those particulars, and for making any particulars contained in the register available for use by the police, and for making the registration of a car void if the regulations as to registration are not complied with; and

(*b*) with respect to the licences to be granted by the councils of counties or county boroughs under this Act, and in particular with respect to the register to be kept of those licences and the renewal of licences, and for providing special facilities for granting licences to persons not resident in the United Kingdom, and for communicating particulars thereof to adjoining and other county or county borough councils, and for making any particulars with respect to any persons whose licences are suspended or endorsed available for use by the police and for preventing a person holding more than one licence.

(2.) The councils of counties and county boroughs shall comply with any regulations so made by the Local Government Board, and may if authorised by those regulations and in accordance therewith charge in respect of the entry of particulars of the ownership of a car on change of ownership such fee, not exceeding ten shillings, as may be prescribed by the regulations, and in respect of the issue of a new licence in the place of a licence lost or defaced such fee not exceeding one shilling as may be prescribed by the regulations.

Power to Prohibit Motor Cars on Special Roads.—8. The Local Government Board may, by regulations made under section six of the principal Act, prohibit or restrict the driving of any motor cars, or of any special kind of motor cars, on any specified highway, or part of a highway, which does not exceed sixteen feet in width, or on which ordinary motor car traffic would, in their opinion, be especially dangerous.

Rate of Speed.—9.—(1.) Section four of the principal Act (which relates to the rate of speed of motor cars) is hereby repealed, but a person shall not, under any circumstances, drive a motor car on a public highway at a speed exceeding twenty miles per hour, and, within any limits or place referred to

in regulations made by the Local Government Board with a view to the safety of the public on the application of the local authority of the area in which the limits or place are situate, a person shall not drive a motor car at a speed exceeding ten miles per hour.

If any person acts in contravention of this provision he shall be liable, on summary conviction in respect of the first offence, to a fine not exceeding ten pounds, and in respect of the second offence to a fine not exceeding twenty pounds, and in respect of any subsequent offence, to a fine not exceeding fifty pounds, but a person shall not be convicted under this provision for exceeding the limit of speed of twenty miles merely on the opinion of one witness as to the rate of speed.

(2.) Where a person is prosecuted for an offence under this section, he shall not be convicted unless he is warned of the intended prosecution at the time the offence is committed, or unless notice of the intended prosecution is sent to him or to the owner of the car as entered on the register within such time after the offence is committed, not exceeding twenty-one days, as the court think reasonable.

(3.) The Local Government Board may, without any application from the local authority, after considering any objections which may be raised by the local authority, revoke or alter any regulation made by them under this section.

(4.) For the purposes of this section the expression local authority means—

(*a*) as respects the City of London, the mayor, aldermen, and commons of the City of London in common council assembled; and

(*b*) as respects a municipal borough with a population of over ten thousand according to the last census taken before the passing of this Act, the council of the borough; and

(*c*) as respects any other area, the county council.

Erection of Notice Boards.—10.—(1.) Local authorities within the meaning of the last preceding section shall give public notice of any regulation of the Local Government Board made in pursuance of this Act prohibiting or restricting the use of motor cars on any highway or part of a highway, or limiting the speed of motor cars within any limits or place, and for the purpose of giving effect to any such regulation shall place notices in conspicuous places on or near the highway, part of a highway, limits, or place to which the regulation refers.

(2.) Subject to regulations as to size and colours to be made by the Local Government Board, local authorities within the meaning of the last preceding section shall, within their areas, cause to be set up sign-posts, denoting dangerous corners, cross-roads, and precipitous places, where such sign-posts appear to them to be necessary.

Penalties and Legal Proceedings.—11.—(1.) A person guilty of an offence under this Act for which no special penalty is provided shall be liable on summary conviction in respect of each offence to a fine not exceeding twenty pounds, or in the case of a second or subsequent conviction to a fine not exceeding fifty pounds, or in the discretion of the court to imprisonment for a period not exceeding three months.

(2.) Any person adjudged to pay a fine exceeding twenty shillings under this Act may appeal against the conviction in the same manner as he may appeal if ordered to be imprisoned without the option of a fine.

Regulations as to Maximum Weight of Cars.—12.—(1.) The Local Government Board by regulations made under section six of the principal Act may, as respects any class of vehicle mentioned in the regulations, increase the maximum weights of three tons and four tons mentioned in section one of that Act, subject to any conditions as to the use and construction of the vehicle which may be made by the regulations.

(2.) The power of the Local Government Board to make regulations under section six of the Locomotives on Highways Act, 1896, shall, as respects

motor cars exceeding two tons in weight unladen, include a power to make regulations as to speed.

Inland Revenue Licence for Motor Car Drivers, 32 *and* 33 *Vict.*, *c.* 14; 39 *and* 40 *Vict.*, *c.* 16.—13. The definition of 'male servant' in sub-section three of section nineteen of the Revenue Act, 1869, as amended by section five of the Customs and Inland Revenue Act, 1876, shall be construed as if a person employed to drive a motor car were included in that definition.

Local Inquiries by Local Government Board, 51 *and* 52 *Vict.*, *c.* 41.—14. Sub-sections one and five of section eighty-seven of the Local Government Act, 1888 (which relates to local inquiries), shall apply for the purpose of the carrying out by the Local Government Board of any of their duties under this Act.

Saving of Liability.—15. Nothing in this Act shall affect any liability of the driver or owner of a motor car by virtue of any statute or at common law.

Application to Servants of the Crown.—16. It is hereby declared that this Act and the principal Act apply to persons in the public service of the Crown.

Protection of Menai Bridge.—17.—(1.) A motor car shall not be driven on or over Menai Bridge except in accordance with regulations made by the Commissioners of Works.

(2.) If any person acts in contravention of this section he shall be liable on summary conviction in respect of the first offence to a fine not exceeding ten pounds, and in respect of the second offence to a fine not exceeding twenty pounds, and in respect of any subsequent offence to a fine not exceeding fifty pounds.

Application to Scotland.—18. In the application of this Act to Scotland—

(1) a reference to the Secretary for Scotland shall be substituted for a reference to the Local Government Board; and

(2) a reference to the council of a royal, parliamentary, or police burgh, containing within its boundaries, as ascertained, fixed, or determined for police purposes, a population according to the census for the time being last taken of or exceeding fifty thousand, shall be substituted for a reference to the council of a county borough, and every other burgh shall be deemed to form part of the county within which it is situate; and

(3) the road authority of any county or of any royal, parliamentary, or police burgh, shall be the local authority within the meaning of the provisions of this Act which relate to the rate of speed and the erection of danger boards; and

52 *and* 53 *Vict.*, *c.* 50.—(4) a reference to sub-sections one and three of section ninety-three of the Local Government (Scotland) Act, 1889, shall be substituted for a reference to sub-sections one and five of section eighty-seven of the Local Government Act, 1888; and

(5) any fine under this Act shall be recoverable by imprisonment in terms of the Summary Jurisdiction Acts; and

(6) any person convicted of an offence under this Act, and ordered to be imprisoned without the option of a fine, or adjudged to pay a fine exceeding ten pounds, shall have a right of appeal against the conviction. Such appeal shall lie to the sheriff depute, and shall be heard summarily. Such appeal may be taken either immediately after the judgment appealed against has been pronounced or within seven days thereafter, and upon such appeal being taken the sentence (if any), shall be suspended until the appeal has been disposed of: provided that the appellant shall, at the time of taking such appeal, lodge in the hands of the clerk of court a bond with sufficient cautioner or otherwise give security satisfactory to the court for appearing before

the sheriff depute. The sheriff depute is hereby authorised and empowered on such appeal to hear evidence, whether led at the original hearing or not, and to reconsider the merits of the case and reverse or confirm in whole or in part the judgment appealed against, or give such new or different judgment as he in his discretion shall think fit; and save as provided by the Summary Prosecutions Appeals (Scotland) Act, 1875, his judgment shall be final and not subject to review; and

(7) An appeal taken in terms of this Act by a person holding a licence against an order for suspension or disqualification shall be taken and disposed of as nearly as may be in the manner and subject to the conditions provided by the immediately preceding sub-section.

Application to Ireland.—19.—In the application of this Act to Ireland—

(1) A reference to the Local Government Board for Ireland shall be substituted for a reference to the Local Government Board; and

51 *and* 52 *Vict.*, *c.* 41.—(2) Sub-sections one and three of article thirty-two of the Local Government (Application of Enactments) Order, 1898, shall be substituted for sub-sections one and five of section eighty-seven of the Local Government Act, 1888; and

14 *and* 15 *Vict.*, *c.* 92.—(3) Section twenty-three of the Summary Jurisdiction (Ireland) Act, 1851 (which gives a right of appeal), shall apply as respects convictions for offences under this Act as if any term of imprisonment without the option of a fine were substituted for a term of imprisonment exceeding one month; and

61 *and* 62 *Vict.*, *c.* 36.—(4) Sections one to four, inclusive, of the Criminal Evidence Act, 1898, shall extend to Ireland in the case of a person charged with any offence under this Act.

Interpretation, Commencement, and Short Title.—20.—(1.) In this Act the expression 'motor car' has the same meaning as the expression 'light locomotive' has in the principal Act, as amended by this Act, except that for the purpose of the provisions of this Act with respect to the registration of motor cars, the expression 'motor car' shall not include a vehicle drawn by a motor car.

The provisions of this Act and of the principal Act shall apply in the case of a roadway to which the public are granted access in the same manner as they apply in the case of a public highway.

(2.) This Act shall come into operation on the first day of January, nineteen hundred and four.

(3.) This Act may be cited as the Motor Car Act, 1903; and the Locomotives on Highways Act, 1896, and this Act may be cited together as the Motor Car Acts, 1896 and 1903.

21.—This Act shall continue in force till the 31st day of December nineteen hundred and six and no longer, unless Parliament shall otherwise determine.

THE MOTOR CAR ACTS: REGISTRATION AND LICENSING

THE LOCAL GOVERNMENT BOARD'S REGULATIONS

The Local Government Board's Regulations for the Registration of Motor Cars and the Licensing of Drivers under the Motor Car Act, 1903, have now been issued, with a circular letter addressed to County Authorities setting forth their duties and responsibilities in connection with the administration of the Act. Both these documents will repay careful study. They are therefore printed here in full, together with certain additional information which is likely to be of service to members when applying for registration or a licence to drive. The Regulations applying to Scotland and Ireland are, for all practical purposes, identical with the English one—see p. 470.

Circular Letter of the Local Government Board on the Motor Car Act, 1903

I am directed by the Local Government Board to draw attention to the provisions of the Motor Car Act, 1903 (3 Edw. 7, c. 36) which amends the law, as contained in the Locomotives on Highways Act, 1896 (59 and 60 Vict., c. 36) with respect to 'light locomotives,' or 'motor cars,' the latter being the expression used in the Act of 1903. The Act of 1903 will come into operation on the 1st day of January next (Sec. 20), and continues in force till 31st day of December, 1906.

Outline of Amendment of Law.—The general scope of the amendments effected by the new Act may be shortly stated. It sets up a system of registration for motor cars, with a view to the more easy identification of the cars and their owners; it requires drivers of these vehicles to possess licences, and provides for penalties in cases where persons drive cars when they do not hold licences or when their licences are suspended on account of offences against the law. It repeals the existing maximum speed limit for motor cars, and substitutes a limit of 20 miles an hour; while at the same time it defines and strengthens those provisions of the law that are aimed at the prevention of the reckless or negligent driving of motor cars, and of indulgence in a rate of speed which, although possibly within the legal limit, is dangerous under the particular circumstances. It also provides for the issue by the Board of regulations, in special cases, having for their object a reduction in particular localities of the maximum limit of speed to 10 miles an hour, or the prohibition or restriction of the driving of motor cars on specified highways of a narrow or other special character.

For the purposes of the Act which relate to the registration of motor cars and the licensing of drivers, the Board are empowered to make regulations taking effect throughout England and Wales. The Board have issued an Order prescribing Regulations for these purposes, and copies of that Order are enclosed.

The effect of the provisions of the Act and of the above-mentioned Regulations is more fully set out below.

Registration of Motor Cars.—By Section 2 of the Act of 1903 a system of registration and identification of motor cars is established; and by Section 7 the Board are empowered to make regulations on such matters as have to be prescribed in order to give effect to the requirements of the earlier section. The Act provides for the registration taking place with the Council of a county or county borough, for the separate numbering of motor cars, for the affixing of identification marks to the cars, and for the payment of certain fees. It also enacts (Sec. 2 (4)), that if a car is used without being registered, or if the mark to be fixed in accordance with the Act is not so fixed, or if, being so fixed, it is in any way obscured, or rendered or allowed to become not easily distinguishable, the driver shall be guilty of an offence under the Act, unless in the case of a prosecution for obscuring a mark, or rendering it or allowing it to become not easily distinguishable, he proves that he has taken all steps reasonably practicable to prevent this result.

If a person proves that he has had no reasonable opportunity of registering a motor car, and that the car is being driven for the purpose of being registered, he is exempt from penalty.

The forging or fraudulent alteration or lending or use of any identification mark is by Section 5 made an offence under the Act.

By Article I. and the First Schedule to the Regulations, the Council of each County and County Borough, who are the registering authorities under the Act in England and Wales, have a letter or a group of two letters (styled the index mark) assigned to them, distinguishing them from any other registering authority under the Act. The Schedule has been prepared in concert

with the Secretary for Scotland and the Local Government Board for Ireland, who are issuing corresponding Regulations for those two countries, and it has been arranged that no use shall be made by English and Welsh registering authorities of the letters G, I, S, V, or Z, the letters G, S, and V being intended to be distinctive of Scottish, and the letters I and Z of Irish registering authorities.

Each registering authority is required to establish and keep a Register of Motor Cars registered with them, and a form in which the Register is to be kept is set out in the Second Schedule.

The Register may, if desired, be kept in two parts—the one part relating to motor cars not being motor cycles, and the other relating to motor cycles.

It may be mentioned that the term motor cycle is not defined in the Act, and the Board have no authority to define it; but they understand that though the term might sometimes properly apply to other vehicles, it would be generally treated as limited to motor cars designed to travel on not more than three wheels, and weighing, unladen, not more than 3 cwt.

The Regulations contain a form in which application may be made for the registration of a car, and require the Council, on receipt of the application and the prescribed particulars and the fee required by the Act (viz., 20*s.* in the case of a motor car not being a motor cycle, and 5*s.* in the case of a motor cycle), to assign a number to the car and register it forthwith. The number to be assigned to the car will be entered in the Register, and being displayed together with the index mark of the Council on the identification plates to be borne by every registered motor car will lead to the identification of the owner should this become necessary. The Council are required on the registration of a car to furnish the owner with a copy of the entries in the Register relating to it. The Regulations deal with the question of changes in the ownership of the car and other alterations affecting the accuracy of the entries in the Register, as well as with the cancellation of entries where this is required. It is important, if the Register is to accomplish its purpose, that alterations in it should be made as needed, and it is desirable that cars which have ceased to exist or have permanently left the country or have become registered elsewhere should be struck off the Register.

The Board contemplate that Councils will usually assign consecutive numbers to cars registered with them. They think, however, that, for purposes of ready identification, it is not desirable that numbers consisting of more than three figures should be assigned, and they will be prepared, if desired, to assign a fresh index mark to any Council who may require to start a fresh series of numbers under a new mark.

The Regulations lay down definite rules with regard to the form and character of the two plates which each motor car has to carry. Two shapes of rectangular plate are permissible, and the owner of the car will elect whichever he prefers. The form of plate, and particulars as to the colour and dimensions of it, and of the inscription on it, are shown in the Fourth Schedule. It is provided that in the case of motor bicycles and tricycles not exceeding 3 cwt. unladen, the dimensions laid down shall be halved, and that the form of the plate need not be rectangular so long as the minimum margin between any letter or figure and the edge of the plate is preserved. This will permit of plates for these motor bicycles and tricycles being oval, or of some other shape than rectangular.

It will be open to the Council if they think fit, and the owner desires it, to supply him with the plates forming the identification mark, and to make a charge for them. If this is not done the owner must procure the necessary plates elsewhere. Designs, identical with the plates, painted or otherwise shown upon the car, may be used instead of actual plates, but the provisions of the Regulations with respect to the plates will apply to any such designs.

With regard to the fixing of the plates on the cars, the great variety in

makes and shapes of cars has made it impossible for the Board to specify the precise place in which the plates are to be fixed. Article VIII. merely requires that the plates shall be fixed one on the front and one on the back of the car, in an upright position, so that the inscription on them shall be upright, and easily distinguishable from in front or behind, as the case may be. In the case of a motor bicycle or tricycle not exceeding 3 cwt. unladen alternative provision is made for the front plate being such that the inscription is visible on either side of the vehicle instead of from in front.

The Regulations, however, require the owner, when applying for the registration of a car, to indicate the position on the car in which it is proposed to place the plates. The Board anticipate that the Council will in the majority of cases have no difficulty in accepting the proposal made by the owner. It not satisfied, however, with the position proposed, the Council may direct the owner to fix the plates in some more satisfactory position, provided that the requirements of the Regulations are complied with.

The Regulations require that at night time the back plate of every motor car used on a public highway shall be illuminated. The illumination may be by means of reflection or transparency or otherwise.

In the case of motor bicycles or tricycles, however, the illumination of the back plate may present some difficulties, and the Regulations will be complied with if either the back plate or the front plate be illuminated. Among other suggestions that have been made is one for the affixing of a thin upright plate, lettered on both sides, and projecting forwards from across the centre of the lens of the head lamp of a cycle.

Article XII. deals with the general identification marks which the Council may assign to manufacturers of or dealers in motor cars in pursuance of Section 2 (4) (*b*) of the Act. These marks will be employed on unregistered cars used on trial after completion or on trial by an intending purchaser. The Regulations allow the mark to be such as the Council direct in each case, so long as it consists of two plates each bearing the index mark of the Council and some other distinguishing letter or letters with some distinguishing number placed thereon or annexed thereto. The shape, design, and measurements of the plates and of the inscription upon them are generally to conform with those prescribed for registered motor cars, but it has been considered desirable that the colouring of the plates shall be different from that used on registered motor cars. It is suggested that white lettering on a red ground would be suitable, and would make these plates readily distinguishable from those carried by registered cars. The manufacturer or dealer is required to keep a record of the distinguishing number placed on the car on each occasion on which the mark is used, and of the name and address of the person then driving the car, and this record is to be open to inspection by the Council or any superior officer of police or duly authorised constable.

The Council have to keep a register of any general identification marks which will contain certain prescribed particulars.

The Register of Motor Cars will not be open to public inspection, but provision is made for its inspection by Officers of Inland Revenue at all reasonable times without charge, and for their taking copies of any entries in it. The Council are also required, on application by any other registering authority in the United Kingdom, or by any police authority or superior officer of police, or constable duly authorised, to provide free of charge a copy of the entries in that Register relating to any specified motor car, or in the Register of general identification marks relating to any specified manufacturer or dealer. A copy of the entries relating to any specified car is also to be supplied to any other person on payment of one shilling if he show that he has a reasonable cause for requiring a copy of the entries.

The Board have limited in this way the right of individuals to obtain information respecting entries in the Register, as they consider that, while no unnecessary obstacle should be placed in the way of a person who requires to

identify a car for the purpose of taking proceedings, the entries in the Register ought not to be made public for the gratification of curiosity or for any other insufficient reason.

The Act, as already mentioned, comes into operation on the 1st January next, but by virtue of Section 37 of the Interpretation Act, 1889, anything may be done before that date that is necessary or expedient for the purpose of bringing the Act into operation at that date. The Regulations will, therefore, to that extent, take effect immediately, and the Council will no doubt at once proceed to establish Registers, and on receipt of applications will register cars under the Act. The registration will, of course, not take effect until the 1st January, but the process of application and of assigning numbers and entering particulars in the Register may be carried out before that time. There is nothing in the Regulations to prevent applications for registration being forwarded to the Council through a third party.

Licensing of Drivers of Motor Cars.—As has been explained, the registration which the Act contemplates is of the motor car itself, and of its ownership. A motor car, however, when registered, cannot under the Act be driven upon a public highway, whether by its owner or by any other person, unless the driver is licensed to drive a motor car. The licence to drive a motor car is a general licence, and is not limited to particular motor cars or particular areas.

The licence must be produced by any person driving a motor car when demanded by a police constable.

Sections 3 and 4 of the Act deal with the grant of licences by the Councils of Counties and County Boroughs, and the circumstances under which a person may become disqualified for obtaining or holding a licence. Section 7 provides for the making of Regulations by the Board on the subject of such licences.

Licences are not to be granted to persons under seventeen years of age, except that a licence limited to the driving of motor cycles may be granted to persons over fourteen years of age.

If a person who resides in a county or county borough applies for a licence to the Council of the County or County Borough, it is the duty of the Council to grant the licence on payment of a fee of five shillings. The licence is not to be granted if the applicant is disqualified under the Act, but the Council have no discretion to withhold a licence on any other ground than that of disqualification. The Regulations issued by the Board provide for the mode in which application is to be made to a Council for a licence and for the form of the licence. A licence remains in force for twelve months, but is then renewable. A licence-holder is disqualified for obtaining another licence while the licence held by him is in force, and no person is to hold more than one licence.

Provisions are contained in Section 4 of the Act, with respect to the circumstances under which offences against the Motor Car Acts may entail the forfeiture for such time as the Court think fit of the right to obtain or to hold a licence to drive a motor car. Those provisions cover cases of offences committed whether by licence-holders or by persons who have not actually taken out licences, and they vary in form accordingly. The section applies to all convictions for offences under the Act of 1903, or for any offences in connection with driving a motor car, except a first or second offence consisting solely of exceeding any limit of speed fixed under the Act. The general effect of the section is to give the Court a discretion to deal with an offender who is a licence-holder by suspending his licence, and declaring him disqualified for obtaining a further licence, and to deal with an offender who does not hold a licence by disqualifying him for obtaining one—the decision in either case to take effect for a period to be ordered by the Court. Provision is also made for the endorsement of an existing licence, with particulars of any conviction and of any order of the Court.

Section 5 of the Act makes it an offence to forge, or fraudulently alter or use, or fraudulently lend or allow to be used by any other person any licence under the Act.

The Regulations made by the Board contain in the Fifth Schedule a form of particulars to be furnished by applicants for licences. In the case of the first applications under the Act the question of disqualification under Section 4 will not arise, and the Council will, therefore, merely need to see that the applicant, if living in the United Kingdom, is resident within the County or County Borough, and that he is not below the limits of age prescribed by the Act. It may be noted that the term motor car in the Regulations, save where the contrary intention appears, includes a motor cycle. A licence to drive a motor car will, therefore, include authority to drive a motor cycle, but a licence to drive a motor cycle will not include authority to drive any other kind of motor car.

The form of licence is prescribed by the Sixth Schedule to the Regulations. A licence will operate for a period of twelve months from the date on which it is expressed to take effect, and an application for its renewal (for which a form is given) may be received and dealt with during the last month of its operation. The licence, if renewed, will operate for a further period of twelve months from the date at which it would otherwise have expired. If the holder of the licence furnishes the Council with his licence for the purpose of renewal, the renewal is to be entered upon the licence. The renewal of the licence will otherwise be a separate document which the holder can attach to the original licence. If not renewed before the expiration of the twelve months the licence will lapse, but it will be open to the holder to apply for a fresh licence at any time afterwards, and, if not disqualified, he will be entitled to be granted one. The fees for a renewal of a licence and for a fresh licence are the same, viz., 5*s.* in each case.

There is nothing in the regulations to prevent application for a licence, if signed by the applicant, being forwarded through a third party, and it is not improbable that this may be done, particularly in the case of persons not resident in the United Kingdom, for the licensing of whom special provision is made in the Act and in the Regulations. Such persons may make application to any Licensing Authority under the Act, and if they are otherwise entitled, licences must be granted to them. (Article XVI.)

If satisfied that a licence granted by them has been lost or defaced, the Council must issue to the licensee, on application, a duplicate licence on payment of a fee of one shilling. The duplicate will have the same effect as the original licence. (Article XVII.)

The Regulations provide (Article XVIII.) for the keeping by the Council of a Register of Licences in the form set out in the Seventh Schedule, and upon application to them by any Licensing Authority in the United Kingdom, or by any police authority, or superior officer of police or duly authorised constable, for their providing free of charge, a copy of the particulars in the Register relating to any licence granted by them. (Article XIX.)

If any licence is endorsed with particulars of a conviction, and of any Order of the Court made under Section 4 of the Act, a copy of those particulars has to be sent to the Council by whom the licence so endorsed was granted, and the Regulations (Article XIX.) require the Council to cause a copy of those particulars to be sent free of charge to the police authority of the area in which the holder of the licence resides.

The Council will, no doubt, at once receive applications for licences. These applications, like applications for registration, may be dealt with before the end of the year, but all licences granted before that time should be expressed to come into operation on the 1st January, and to continue until the 31st December, 1904, inclusive.

Restrictions on the Free Circulation of Motor Cars and Reckless Driving. By Section 4 of the Locomotives on Highways Act, 1896, it was provided that

no motor car should travel along a public highway at a greater speed than 14 miles an hour, or than any less speed that might be prescribed by regulations of the Board.

That section is repealed by Section 9 of the Act of 1903, and by the last-mentioned section a maximum speed limit of 20 miles an hour is imposed. The section also enacts that within any limits or place referred to in regulations made by the Board, with a view to the safety of the public, on the application of the local authority of the area in which the limits or place are situate, a person is not to drive a motor car at a speed exceeding 10 miles an hour; and the expression 'local authority' in this section is defined as meaning (outside the City of London) the County Council, or, in the case of a municipal borough with a population of over ten thousand, the council of the borough. If a regulation is made by the Board under this section, it may be revoked or altered by them without any application from the local authority; but the Board are required, before revoking or altering any such regulations, to consider any objections which may be raised by the local authority.

Section 8 of the Act of 1903 empowers the Board to prohibit or restrict the driving of motor cars, or of any special kind of motor cars, on any specified highway, or part of a highway (*a*) which does not exceed 16 ft. in width, or (*b*) on which ordinary motor car traffic would, in their opinion, be especially dangerous. It will thus be seen that the section has in view only highways of an exceptional character.

As to the former of these two classes of roads the Board are advised that the measurement of 16 ft. in width mentioned in the section must ordinarily be taken to refer to the space between the fences or other boundaries of the highway. If on any particular highway that space exceeds 16 ft., whether the width of the metalled surface available for traffic is 16 ft. or less, the case can only be dealt with if it can be brought within the latter part of the section.

Section 8 does not preclude the Board from acting without being set in motion by a formal application, but they think it would be convenient that applications to them to exercise powers under this section should be made by or through the local authorities who are empowered to make applications under Section 9.

The provisions which have just been noticed relate either to the absolute speed of motor cars, measured in miles per hour, or to the prohibition and restriction of motor car traffic. These provisions, however, afford no sufficient indication of the rules which should be observed by the driver of a motor car, if he is to regulate his pace with due regard to the convenience and safety of other persons using the highway. It has been well established that upon suitable roads and in suitable circumstances a driver may approach the maximum rate of speed without risk to other persons, whilst under different circumstances serious danger might arise from a motor car driven at a pace much below the maximum. One main object of the Act of 1903 was to facilitate the dealing with cases which could not be touched by the provisions relating to fixed speed limits. The important provisions contained in Section 1 of the Act effect this object by at once defining and strengthening the law relating to the driving of motor cars, without reference to the question of absolute pace. The section provides that if any person drives a motor car on a public highway (*a*) recklessly or (*b*) negligently or (*c*) at a speed or in a manner which is dangerous to the public, having regard to all the circumstances of the case, including the nature, condition, and use of the highway, and to the amount of the traffic which actually is at the time, or which might reasonably be expected to be, on the highway, that person shall be guilty of an offence under the Act. Such an offence carries with it a liability to a fine of twenty pounds or (in the case of a second or subsequent conviction) to a fine of fifty pounds, or, in the discretion of the Court, imprisonment for three months (Sec. 11).

A comparison of these provisions with the corresponding provisions of the

Act of 1896, as to offences and penalties, and a perusal of the later paragraphs of this Circular dealing specially with the question of penalties, will show that under the new law the driver of a motor car is under considerably more statutory restraint than heretofore, and that he incurs a much more serious liability if he fails to observe the conditions imposed upon him. As the terms of Section 1 indicate, either reckless driving, or negligent driving, or driving at a speed or in a manner which is actually dangerous having regard to the circumstances specified in the section, may be a separate ground of conviction for an offence against the Act; and whilst the maximum penalty for an offence under the Act of 1896 was ten pounds, an offence under the Act of 1903 renders the offender liable to much heavier penalties.

On an offence being committed under Section 1 within view of a police constable, if the driver refuses to give his name and address or produce his licence on demand, or if the motor car does not bear the identification mark or marks, the driver may be apprehended without a warrant. Further, the refusal by an offending driver to give his name or address, or the giving of a false name or address, is an additional offence, and the owner, if required, is under an obligation to give such information as he can, with a view to the identification and apprehension of the driver.

In view of the provisions of Section 1, of the serious penalties to which offenders are made liable under the Act, and of the means of identification for which the statute now provides, there is ground for the expectation of a diminution in the number of cases of furious driving and of disregard of the safety and convenience of other users of the roads which have occurred in the past among certain classes of motorists, and the Board are accordingly disposed to recommend local authorities to refrain from proposing any extended resort to the powers of Sections 8 and 9 of the Act until it is seen that the other provisions of the statute render such a resort indispensable. It will be remembered that any widespread imposition of restrictions and special speed limits will not only be somewhat burdensome to motorists, but will involve local authorities in considerable trouble and expense in carrying out the requirements of Section 10, which provides that they are to give public notice of any regulation made by the Board, prohibiting or restricting the use of motor cars on a highway or part of a highway or limiting the speed of motor cars within any limits or places, and for the purpose of giving effect to any such regulation are to place notices in conspicuous places in or near the highway, limits, or place affected.

The characteristics and number of any such notices are left by the Act to the discretion of the Council. It is clear, however, that it is desirable that there should be some degree of uniformity in the kind of notice which may have to be exhibited for the above purpose, and it would be well if the authorities concerned, through the medium of central associations or otherwise, were to endeavour to arrive at some agreement on the subject. It is suggested that in the case of any limits or place to which the 10 miles an hour limit of speed is made applicable, it might be sufficient, as a rule, if the notice board were of a distinctive colour, and bore upon it in conspicuous letters, on the side visible to motorists approaching the area within which the speed limit is imposed, a statement to the effect that the rate of speed is to be reduced to 10 miles an hour within the limits or place briefly described on the notice board. The other side of the board might be indicative to drivers coming in the opposite direction of the conclusion of the restriction. It would not seem necessary or desirable that the text of the regulations should be printed on the notice boards.

In the case of notice boards relating to regulations which may have to be made under Section 8, it would be desirable that the notice should be sufficient to apprise the drivers of motor cars of the nature of the regulation, and of the character and extent of the highway to which it applies. In these cases also it would probably be advisable that a distinctive colouring of the notice board and of the lettering should be adopted.

Weight of Motor Cars.—Under Section 1 of the Locomotives on Highways Act, 1896, the weight of a motor car used alone is limited to three tons, whilst a motor car used for drawing another vehicle must not, together with the other vehicle, exceed four tons in weight. The weights refer to unladen motor cars and vehicles.

Section 12 of the Act of 1903 empowers the Board by regulations to increase the weights referred to, as regards any class of vehicle, subject to any conditions as to the use and construction of the vehicle which may be made by the regulations. Further, the Board may make regulations as to the speed of motor cars exceeding two tons in weight unladen.

The questions which arise as regards any vehicles which are to be used subject to the law as to motor cars, although exceeding three tons in weight, are of considerable importance; and the Board have deemed it expedient that a Departmental Committee should be appointed to consider the subject in all its bearings. Among other matters of moment which have to be considered in this connection is the question of the suitability of existing highways and bridges for the passage over them of this type of vehicle, and generally the scope of the conditions which should attach to traffic of this character upon highways.

Until the Committee have reported and the Report has been considered, the Board cannot anticipate being able to issue regulations under this Section.

Penalties and Legal Proceedings.—Section 11 of the Act provides that a person guilty of an offence under the Act for which no special penalty is imposed shall be liable on summary conviction in respect of each offence to a fine not exceeding 20*l.*, or in case of a second or subsequent conviction to a fine not exceeding 50*l.*, or in the discretion of the Court to imprisonment for a period not exceeding three months.

The following are the offences to which the foregoing provision applies :—

(1.) Reckless, negligent, or dangerous driving within the meaning of Section 1 (1).

(2.) Refusal on the part of a driver who commits an offence under Section 1 (1) to give his name or address, or the giving of a false name and address (Sec. 1 (3)).

(3.) Failure on the part of the owner of a car to give information within his power leading to the identification and apprehension of the driver (Sec. 1 (3)).

(4.) Subject to the exceptions and provisions stated in Section 2, driving a car on a public highway without it being registered, or without having the identification mark properly fixed, or with the mark in any way obscured, or rendered or allowed to become not easily distinguishable (Sec. 2 (4)).

(5.) Driving a motor car without being licensed under the Act or employing an unlicensed person to drive (Sec. 3 (1)).

(6.) Failure of a licence-holder on conviction for offences as specified in the section to produce the licence within a reasonable time for the purposes of endorsement (Sec. 4 (2)).

(7.) Applying for or obtaining a licence while disqualified, or applying for or obtaining a licence without giving particulars of endorsements on a previous licence (Sec. 4 (5)).

(8.) Forging or fraudulently altering or using or fraudulently lending or allowing to be used by any other person, any identifying mark or any licence under the Act (Sec. 5).

Other offences for which special penalties are prescribed by the Act are the following :—

(1.) Failure by the driver of a motor car to produce a licence when demanded by a police constable renders him liable to a fine not exceeding 5*l.* (Sec. 3 (4)).

(2.) A person driving a motor car, if an accident occurs to any person

whether on foot or horseback or in a vehicle or to any horse or vehicle in charge of any person, owing to the presence of the motor car on the road, is bound to stop and if required give his name and address and also the name and address of the owner and the registration mark and number of the car; and if any person knowingly acts in contravention of this provision he becomes liable on summary conviction in respect of the first offence to a fine not exceeding 10*l.*, in respect of the second offence to a fine not exceeding 20*l.*, and in respect of any subsequent offence to a fine not exceeding 20*l.* or in the discretion of the Court to a term of imprisonment not exceeding one month (Sec. 6).

(3.) Infringement of any speed limits imposed by or under Section 9 of the Act renders the person convicted liable in respect of the first offence to a fine not exceeding 10*l.*, in respect of the second offence to a fine not exceeding 20*l.*, and in respect of any subsequent offence to a fine not exceeding 50*l.* (Sec. 9). In proceedings under this section a person cannot be convicted unless he is warned of the intended prosecution at the time the offence is committed or notice of the intended prosecution is sent to him or to the registered owner of the car within such time after the offence is committed, not exceeding twenty-one days, as the Court think reasonable nor can he be convicted for exceeding the limit of speed of twenty miles per hour merely on the opinion of one witness as to the rate of speed.

(4.) The infringement of regulations made by the Commissioners of Works respecting the use of motor cars on Menai Bridge renders the offender subject to penalties similar to those for offences against speed limits (Sec. 17).

(5.) Regulations made by the Board in pursuance of Sections 7, 8, and 12 of the Act are declared to be made under Section 6 of the Locomotives on Highways Act, 1896, and consequently Section 7 of that Act, which provides that a breach of any regulation made under it may, on summary conviction, be punished by a fine not exceeding 10*l.*, will apply to them.

Not only are offenders liable to the penalties already specified, but Section 4, which has been before referred to in this circular, provides for the endorsement on conviction of any licence under the Act held by the offender, and in the discretion of the Court for his disqualification by suspension and otherwise for holding a licence for such time as the Court think fit. This penalty attaches to any offence under the Act or any offence in connection with the driving of a motor car other than a first or second offence consisting solely of exceeding any limit of speed fixed under the Act (Sec. 4).

Section 15 of the Act further provides that nothing in it shall affect any liability of the driver or owner of a motor car by virtue of any statute or at common law.

Offences under the Act or the Regulations will be punishable on summary conviction. Any person adjudged to pay a fine exceeding 20*s.* under the Act, or who is by virtue of an Order of the Court under Section 4 disqualified for obtaining a licence may appeal against the conviction or the Order as the case may be in the same manner as a person may appeal who is ordered to be imprisoned without the option of a fine. In this connection reference may be made to Sections 19 and 31 of the Summary Jurisdiction Act, 1879.

Miscellaneous.—A few other points remain to be noticed. Section 10 (2) of the Act provides that County Councils and the Councils of Boroughs with populations exceeding 10,000 at the Census of 1901 shall, within their areas, cause to be set up sign posts denoting dangerous corners, cross roads and precipitous places where such sign posts appear to them to be necessary, subject to regulations as to size and colours to be made by the Board. A separate communication will be made to the local authorities concerned in regard to this matter.

Under Section 6 of the Locomotives on Highways Act, 1896, the Board were empowered to make regulations with respect to the use of motor cars on highways, and their construction, and the conditions under which they may be used ; and such regulations were prescribed by an Order issued on the 9th November, 1896. As the result of the passing of the Motor Car Act, 1903, and of the experience gained since 1896, some of the regulations contained in the Order of 9th November, 1896, need amendment ; and, in consequence, the Board will issue an Order rescinding those regulations, and prescribing others in place of them.

By Section 13 a male person employed to drive a motor car is deemed to be a male servant for purposes of licence duty. The Board have, however, been informed by the Inland Revenue Commissioners that they do not propose to require the payment of male servant licence duty in respect of servants employed to drive motor vehicles which are properly inscribed with the owner's name and address, and used solely for the conveyance of goods or of instruments of trade or husbandry, so as to be within the scope of the exemption from carriage licence duty conferred in favour of trade carts.

REGULATIONS (REGISTRATION AND LICENSING)

In pursuance of the powers given to us by the Act of 1896 and the Act of 1903, and by any other Statutes in that behalf, we, the Local Government Board, do by this our Order make the following Regulations, and direct that the same shall have effect for the purpose of bringing the Act of 1903 into operation and giving effect to that Act :—

Part I

REGISTRATION OF MOTOR CARS

Article I.—The Council of every County and the Council of every County Borough shall establish and keep a Register (thereinafter referred to as the ' Register of Motor Cars ') for the registration of motor cars.

The index mark distinguishing the Council of the County or County Borough with which a motor car is registered shall, as respects the Council of each County or County Borough, be the letter or letters shown opposite to the name of that Council in Part I. of the First Schedule to this Order.

The Register of Motor Cars shall be in the form set out in the Second Schedule to this Order, or in a form to the like effect.

The Council of any County or County Borough may, if they think fit, keep the Register of Motor Cars in two parts, one part relating to motor cars not being motor cycles, and the other part relating to motor cycles.

Article II.—The owner of a motor car who desires to register it with the Council of any County or County Borough shall apply to the Council, and shall furnish them with the particulars set out in the Form in the Third Schedule to this Order. A fee of twenty shillings in the case of a motor car not being a motor cycle, or of five shillings in the case of a motor cycle, being the fee prescribed by the Act of 1903, shall be paid before the motor car can be registered.

Article III.—The Council, on receipt of any such application, and the particulars and fee above referred to, shall forthwith assign a separate number to the motor car, and register it by making the required entries in the Register of Motor Cars. The Council, on the registration of a motor car, shall forthwith furnish the owner of the motor car with a copy of entries in the Register relating to the motor car.

Article IV.—If the ownership of a motor car is changed, notice of the change shall be given either by the new or the old owner to the Council with

whom the motor car is registered, and an application shall also be made either to cancel the registration of the car or to continue the existing registration under the new ownership.

If an application is so made to cancel the registration of the motor car, and no application is made to continue the existing registration of the car, the registration of the car shall be cancelled accordingly, but if an application is made to continue the existing registration of the car, the new owner shall furnish the necessary particulars as to ownership, and on receipt of a fee of five shillings in the case of a motor car not being a motor cycle, or of one shilling in the case of a motor cycle (which fees the Council are hereby authorised to charge), the Council shall cause the necessary alterations to be made in the Register of Motor Cars, and shall furnish the new owner with a copy of the altered entries in the Register.

Any notice may be given or application or alteration made under this Article before the date of the actual change of ownership so as to take effect from that date.

If the provisions of this Article as to notice and application are not complied with, the registration of the motor car shall be void.

ARTICLE V.—If any circumstance (other than a change of ownership dealt with in the preceding Article) occurs in relation to any motor car which affects the accuracy of any particulars entered as respects that car in the Register of Motor Cars, the owner of the motor car shall forthwith inform the Council with whom it has been registered, and on receipt of such information the Council shall forthwith cause the entries respecting that motor car in the Register of Motor Cars to be amended accordingly, and shall furnish the owner with a copy of the entries as so amended. No fee shall be charged by the Council in respect of any amendment of entries or transmission of a copy of entries under this Article.

ARTICLE VI.—If the Council are satisfied that a motor car which has been registered with them is destroyed, broken up, or permanently removed from the United Kingdom or registered with another registering authority under the Act of 1903, or if the owner of a registered motor car, by application in writing, requests them to cancel the registration thereof (except where, in the case of a change of ownership, there is an application to continue the existing registration), they shall cause the entries in the Register of Motor Cars with respect to the motor car to be cancelled, and may, if they think fit, assign the registered number of the motor car to any other motor car, whether belonging to the same or any other owner.

ARTICLE VII.—The mark to be carried by a registered motor car, in pursuance of Section 2 of the Act of 1903 (in this Order referred to as the identification mark), shall consist of two plates, which must conform as to lettering, numbering, and otherwise, with the provisions set out in the Fourth Schedule to this Order.

Designs, painted or otherwise, shown upon the motor car may, if it is desired, be used instead of plates, and any reference to plates in this Order shall be construed to include a reference to such designs, and any reference to the fixing of plates to include a reference to the painting or other delineation of the designs.

ARTICLE VIII.—The plates forming the identification mark shall be fixed, one on the front of, and the other on the back of, the motor car, in an upright position, so that every letter or figure on the plate is upright and easily distinguishable, in the case of the plate placed on the front of the motor car, from in front of the car, and, in the case of the plate placed on the back of the motor car, from behind the car.

In the case of a motor tricycle or motor bicycle of a weight unladen not exceeding three hundredweights, the plate fixed on the front of the cycle may, if it is a plate having duplicate faces conforming with the Fourth Schedule to this Order, be fixed so that from whichever side the cycle is viewed the letters

or figures on one or other face of the plate are easily distinguishable, though they may not be distinguishable from the front of the cycle.

Subject to the provisions of this Article, the plates forming the identification mark shall be fixed on the motor car in the position indicated in the particulars given on the application for the registration of the motor car, or subsequently furnished to the registering Council, or if that Council are not satisfied with the position so indicated, in such a position as they direct.

So long as the provisions of this Order are complied with, different dentification plates may be used on a motor car by day and night or on different occasions.

ARTICLE IX.—When another vehicle is attached to a motor car, either in front or behind, the plate required to be fixed on the front or on the back of the motor car, or a duplicate of such plate, shall be fixed on the front or on the back of the vehicle attached, as the case requires, in the same manner as the plate is required to be fixed upon the motor car.

ARTICLE X.—A Council with whom a motor car is registered may, if they think fit, supply to the owner of the car, if he so desires, the plates forming the identification mark on the car, and make a charge for them.

ARTICLE XI.—Whenever during the period between one hour after sunset and one hour before sunrise a motor car is used on a public highway, a lamp shall be kept burning on the car, so contrived as to illuminate by means of reflection, transparency, or otherwise, and render easily distinguishable every letter or figure on the identification plate fixed on the back of the motor car or of any vehicle attached to the back of the motor car, as the case may be.

In the application of this Article to a motor tricycle or motor bicycle of a weight unladen not exceeding three hundredweights, the plate fixed on the front of the motor car may, if desired, be substituted for the plate fixed on the back of the motor car.

ARTICLE XII.—If the Council of any County or County Borough assign to a manufacturer or dealer a general identification mark under proviso (*b*) to Sub-section (4) of Section 2 of the Act of 1903, the mark shall be such as the Council direct in each case. Provided that :—

(*a*) It shall consist of two plates, each bearing the index mark of the Council and some other distinguishing letter or letters ; and each having placed thereon or annexed thereto some distinguishing number ; and

(*b*) The colouring of the plates shall be different from that used for the plates forming the ordinary identification mark ; and

(*c*) The lettering and numbering of the plates shall, so far as possible, be similar to those required in the case of the plates forming the ordinary identification mark.

On every occasion on which the general identification mark is used on a motor car, the manufacturer or dealer shall keep a record of the distinguishing number placed on or annexed to the identification plates on that occasion, and of the name and address of the person driving the motor car on that occasion, and that record shall be open to inspection by the Council or by any superior officer of police or constable authorised by such an officer.

If the general identification mark is used at the same time on more than one motor car, the distinguishing number placed on or annexed to the plates must be different on each motor car.

The provisions of this Order which relate to the fixing and illumination of identification plates shall apply to the plates forming the general identification mark as they apply to the plates forming the ordinary identification mark.

The Council shall keep a register of any general identification marks so assigned by them which shall contain the following particulars :—

(*a*) The name of the manufacturer or dealer to whom the general identification mark is assigned ;

(*b*) the place of business of the manufacturer or dealer ; and

(*c*) a description of the general identification mark assigned to him.

ARTICLE XIII.—The Council shall, upon application being made to them by any other registering authority under the Act of 1903, or by any police authority, or by any superior officer of police or constable authorised by such an officer, forthwith provide, free of charge, a copy of the entries in their Register of Motor Cars relating to any specified motor car, or of the entries in their Register of general identification marks relating to any specified manufacturer or dealer. The Council shall also supply to any other person applying for a copy of the entries relating to any specified motor car a copy of those entries on payment of a fee of one shilling, if he shows that he has a reasonable cause for requiring such a copy.

An officer of the Inland Revenue Department may, without charge, at all reasonable times inspect the Register of Motor Cars and take copies of any entries in it.

PART II

LICENCES

ARTICLE XIV.—A person who desires to obtain the grant or renewal of a licence to drive a motor car or of a licence limited to driving motor cycles under the Act of 1903 shall apply to the Council of the County or County Borough in which he resides, and furnish them with the particulars set out in Form A or Form B in the Fifth Schedule to this Order, as the case requires.

The fee of five shillings prescribed by the Act of 1903 shall be paid before the applicant is entitled to receive the licence or renewal.

Applications for the grant or renewal of a licence may be received and dealt with at any time within one month before the date on which the grant or renewal of the licence is to take effect.

ARTICLE XV.—The licence and renewal of a licence shall respectively be in the form set out for the purpose in the Sixth Schedule to this Order or in a form to the like effect.

ARTICLE XVI.—If any person applies to the Council of a County or County Borough for the grant of a licence, and the Council are satisfied that he has no residence in the United Kingdom, the Council shall, if the applicant is otherwise entitled, grant him a licence, notwithstanding that he is not resident within their County or County Borough.

ARTICLE XVII.—If a person to whom a licence has been granted by the Council of a County or County Borough satisfies that Council that his licence or any renewal of it has been lost or defaced, the Council shall, on payment of a fee of one shilling, issue to him a duplicate licence, or renewal (including, in the case of a duplicate licence, any particulars endorsed or entered upon the original licence under the Act of 1903 or this Order), and the duplicate so issued shall have the same effect as the original licence or renewal, as the case may be.

ARTICLE XVIII.—The Council of every County and County Borough shall establish and keep a Register of Licences in the form set out in the Seventh Schedule to this Order, or in a form to the like effect.

ARTICLE XIX.—Any registering Council shall upon application being made to them by any other licensing authority under the Act of 1903, or by any police authority, or by any superior officer of police or constable authorised by such officer forthwith provide free of charge a copy of the particulars in their Register of Licences relating to any licence granted by them.

Upon receiving from any Court in pursuance of Section 4 of the Act of 1903 particulars of any conviction of the holder of a licence granted by the Council, and of the Order of the Court in the case, the Council shall cause a copy of such particulars and Order to be sent, free of charge, to the police authority for the area in which the holder of the licence resides.

PART III

SUPPLEMENTAL

ARTICLE XX.—The clerk of the Council, and any other officer authorised by the Council, are respectively empowered to perform any duty or exercise any power of the Council for the purpose of carrying this order into effect.

ARTICLE XXI.—The provisions of this Order shall apply in the case of a roadway to which the public are granted access in the same manner as they apply in the case of a public highway.

Except where the contrary intention appears, the expression 'motor car' in this Order includes a motor cycle.

In calculating for the purpose of this Order the weight of a motor car or motor cycle unladen, the weight of any water, fuel, or accumulators used for the purpose of propulsion shall not be included.

The Interpretation Act, 1889, applies for the purpose of the interpretation of this Order as it applies for the purpose of the interpretation of an Act of Parliament.

ARTICLE XXII.—This Order may be cited as the Motor Car (Registration and Licensing) Order, 1903.

THIRD SCHEDULE

Form of Particulars to be given by Applicant for Registration of a Motor Car

COUNTY [or COUNTY BOROUGH] of ____________

1. Full name of owner.	
2. Postal address of usual residence of owner.	
3. Description or type of car (*a*).	
4. (*b*) Type and colour of body of car (*c*).	
5. Weight unladen.	
6. Whether intended for— (*a*) Private use, or (*b*) Use for trade purposes, or (*c*) Use as a public conveyance.	
7. Particulars as to the position on the car in which it is proposed to place the plates forming the identification mark.	

Signature of owner or person applying on his behalf ____________

Date of Application ____________

(*a*) *e.g.*, a 12 h.-p. car, or a steam lorry, or electric brougham, or motor bicycle, with the addition in each case of the name of the maker, or the name by which the type is ordinarily known.

(*b*) In the case of a motor cycle, particulars under this head need not be given.

(*c*) *e.g.*, tonneau body painted yellow, or dog cart body painted black picked out with red, or van body painted blue with the name of the firm upon it.

FOURTH SCHEDULE

Alternative Diagram No. 1

Alternative Diagram No. 2

The alternative diagrams above are specimen plates drawn approximately to a scale of one-sixth. The actual size of the plates will, however, differ according to the number of letters and figures required.

Provisions to be complied with.—(1.) Each plate must be rectangular, and bear upon it the index mark of the Council with whom the motor car is registered and the separate number assigned to the motor car by that Council, the mark and number being arranged in conformity with the arrangement of letters and figures shown on one or other of the alternative diagrams.

(2.) The two plates may, at the option of the owner, be of either of the shapes shown in the alternative diagrams, or one of one shape and one of the other.

(3.) The ground of the plate must be black, the letters and figures must be white.

(4.) All letters and figures must be three and a-half inches high; every part of every letter and figure must be five-eighths of an inch broad; and the total width of the space taken by every letter or figure, except in the case of the figure 1, must be two and a-half inches.

(5.) The space between adjoining letters and between adjoining figures must be half an inch, and there must be a margin between the nearest part of any letter or figure and the top and bottom of the plate of at least half an inch, and between the nearest part of any letter or figure and the sides of the plate of at least one inch.

(6.) In the alternative diagram No. 1, the space between the upper and lower line must be three-quarters of an inch. In the alternative diagram No. 2, the space between the letters and the figures must be one and a-half inches.

(7.) In the case of the plates for a motor tricycle or motor bicycle of a weight unladen not exceeding three hundredweights, each of the dimensions mentioned above must be halved, and the shape of the plate need not be rectangular so long as the *minimum* margin between any letter or figure and the top, bottom, and sides of the plate is preserved.

FIFTH SCHEDULE

Form A

Particulars to be given by Applicant for Licence

County [or County Borough] of____________________

1. Full name of applicant.	
2. Postal address of residence of applicant.	
3. Whether application is for licence to drive a motor car, or for licence limited to driving motor cycles.	
4. Whether applicant is less than seventeen years of age, or, in the case of an application limited to driving motor cycles, whether he is less than fourteen years of age.	
5. Whether applicant is the holder of a licence, or has at any time previously been the holder of a licence.	
6. Particulars of any licence which the applicant holds or which he has previously held.	
7. Particulars of any endorsement on any licence which the applicant holds or which he has previously held.	

8. Whether applicant has at any time been disqualified for obtaining a licence. If so, particulars as to the Court by whom, the date on which, and the period for which the disqualification was imposed.	

*Signature of Applicant*__________

*Date of Application*__________

Form B

Particulars to be given by Applicant for Renewal of Licence

County [or County Borough] of__________

1. Number of the licence.	
2. Postal address of residence of applicant.	
3. Whether applicant has, since date of last grant or renewal of the licence, been disqualified for obtaining a licence.	

*Signature of Applicant*__________

*Date of Application*__________

REGISTRATION AND LICENSING AUTHORITIES

The following is a list of the Registration and Licensing Authorities of the United Kingdom. It must be understood that automobilists can register their cars with any registration authority, but they can only take out licences to drive in the county or county borough in which they reside. The county boroughs include only the large towns of the United Kingdom, and separate lists are given of these boroughs. Automobilists residing in a non-county borough (and the majority of boroughs are non-county boroughs), as well as all those residing in urban districts and rural districts, must apply to the County Council and not to the Clerk to the Borough or District Council for their licences. For example, an automobilist residing in the Borough of Harrogate would have to write to the Clerk to the County Council for the West Riding of Yorkshire at Wakefield for his licence. Another living in the urban district of Hitchin would write to the Clerk to the Hertfordshire County Council at Hertford; while a third, living in the rural district of Epping, would apply to the County Council of Essex at Chelmsford.

In the county of London all applications for licences must be made to the Clerk to the London County Council at Spring Gardens, S.W., and not to the Borough Councils or to the Corporation of the City of London.

England

COUNTY COUNCILS

In the following list the towns in which the offices of the County Councils are situate are given, and letters should be addressed 'The Clerk to the County Council of ____ County Council Offices, ____ ':—

Bedfordshire	Shire Hall, Bedford
Berkshire	Reading
Buckinghamshire	Aylesbury
Cambridgeshire	Cambridge
Cheshire	Chester
Cornwall	Bodmin
Cumberland	Carlisle
Derbyshire	Derby
Devonshire	Exeter
Dorsetshire	Sherborne
Durham	Durham
Essex	Chelmsford
Gloucestershire	Shire Hall, Gloucester
Hampshire	See Southampton
Herefordshire	Hereford
Hertfordshire	Hertford
Huntingdonshire	Huntingdon
Isle of Ely	Wisbech
Isle of Wight	Newport, I. W.
Kent	Maidstone
Lancashire	Preston
Leicestershire	Leicester
Lincolnshire (Holland)	Boston
Lincolnshire (Kesteven)	Stamford
Lincolnshire (Lindsey)	Lincoln
London	Spring Gardens, S.W.
Middlesex	Guildhall, Westminter, S.W.
Monmouthshire	Newport, Mon.
Norfolk	Shire House, Norwich
Northamptonshire	County Hall, Northampton
Northumberland	Newcastle-on Tyne
Nottinghamshire	Nottingham
Oxfordshire	Oxford
Peterborough, Soke of	Peterborough
Rutlandshire	Oakham
Salop	Shrewsbury
Somersetshire	Frome
Southampton	Winchester
Staffordshire	Stafford
Suffolk, East	Ipswich
Suffolk, West	County Hall, Ipswich
Surrey	County Hall, Kingston-on-Thames
Sussex, East	Lewes
Sussex, West	Lewes
Warwickshire	Leamington
Westmoreland	Kendal
Wiltshire	Trowbridge
Worcestershire	Worcester
Yorkshire (East Riding)	Beverley
Yorkshire (North Riding	Northallerton
Yorkshire (West Riding)	Wakefield.

COUNTY BOROUGHS

In the case of County Boroughs, letters should be addressed, 'The Town Clerk, Town Hall, ___ .'

Barrow
Bath
Birkenhead
Birmingham
Blackburn
Bolton
Bootle
Bournemouth
Bradford
Brighton
Bristol
Burnley
Burton-on-Trent
Bury
Canterbury
Chester
Coventry
Croydon
Derby
Devonport
Dudley
Exeter
Gateshead
Gloucester
Grimsby
Great Yarmouth
Halifax
Hanley

ENGLAND—COUNTY BOROUGHS (*continued*)

Hastings	Newcastle-on-Tyne	Preston	Sunderland
Huddersfield	Newport, Mon.	Reading	Walsall
Ipswich	Northampton	Rochdale	Warrington
Kingston-on-Hull	Norwich	Rotherham	West Bromwich
Leeds	Nottingham	Saint Helens	West Ham
Leicester	Oldham	Salford	West Hartlepool
Lincoln	Oxford	Sheffield	Wigan
Liverpool	Plymouth	Southampton	Wolverhampton
Manchester	Portsmouth	South Shields	Worcester
Middlesbrough		Stockport	York.

WALES

COUNTY COUNCILS

Address, 'The Clerk to the County Council of ____, County Council Offices, ___.'

Anglesey	Holyhead	Glamorganshire	Cardiff
Brecknockshire	Brecon	Merionethshire	Portmadoc
Cardiganshire	Aberystwith	Montgomeryshire	Welshpool
Carmarthenshire	Llandovery	Pembrokeshire	Haverford-west
Carnarvonshire	Carnarvon	Radnorshire	Rhayader.
Denbighshire	Ruthin		
Flintshire	Mold		

COUNTY BOROUGHS

Address, 'The Town Clerk, Town Hall, ___.'

Cardiff	Swansea

SCOTLAND

COUNTY COUNCILS

Address, 'The Clerk to the County Council of ____, County Council Offices, ____.'

Aberdeen	Aberdeen	Elgin	Elgin
Argyll	Lochgilphead	Fife	County Bgs., Cupar
Ayr	County Bgs., Ayr	Forfar	Forfar
Banff	Banff	Haddingtonshire	Haddington
Berwick	Duns	Inverness	High Street, Inverness
Bute	Rothesay	Kincardine	County Bgs., Stonehaven
Caithness	Thurso	Kinross	County Bgs., Kinross
Clackmannan	County Bgs., Alloa	Kirkcudbright	Kirkcud-bright
Dumbarton	County Bgs., Dumbarton	Lanarkshire	County Bgs., Hamilton
Dumfries	County Bgs., Dumfries		
Edinburgh	Edinburgh		

SCOTLAND—COUNTY COUNCILS (*continued*)

Linlithgow	Linlithgow
Nairn	Nairn
Orkney	Kirkwall
Peebles	Peebles
Perth	County Bgs., Perth
Renfrew	County Bgs., Paisley
Ross and Cromarty	County Bgs., Dingwall
Roxburgh	Kelso
Selkirk	Selkirk
Stirling	Stirling
Sutherland	Golspie
Wigtown	Wigtown
Shetland	Lerwick.

REGISTRATION AND LICENSING BURGHS

Address, 'Town Clerk, Town Hall, _____.'

Aberdeen	Edinburgh	Govan	Leith	Partick
Dundee	Glasgow	Greenock	Paisley	

IRELAND

COUNTY COUNCILS

Address, 'The Clerk to the County Council of _____, County Council Offices, _____.'

Antrim	Belfast
Armagh	Armagh
Carlow	Court House, Carlow
Clare	Ennis
Cavan	Cavan
Cork	Court House, Cork
Donegal	Donegal
Down	County Court House, Downpatrick
Co. Dublin	Dublin
Fermanagh	Court House, Enniskillen
Galway	County Court House, Galway
Kerry	Court House, Tralee
Kildare	Kildare
Kilkenny	Court House, Kilkenny
King's Co.	Court House, Tullamore
Leitrim	Court House, Carrick-on-Shannon
Limerick	Limerick
Londonderry	County Court House, Londonderry
Longford	Edgeworthston
Louth	Court House, Dundalk
Mayo	Castlebar
Meath	Navan
Monaghan	Court House, Monaghan
Queen's Co.	Court House, Maryborough
Roscommon	County Council Chambers, Court House, Roscommon
Sligo	County Court House, Sligo
Tipperary	Court House, Clonmel
Tyrone	Court House, Omagh, Co. Tyrone
Waterford	Court House, Waterford
Westmeath	Court House, Mullingar
Wexford	Court House, Wexford
Wicklow	Court House, Wicklow

COUNTY BOROUGHS

Address, 'The Town Clerk, Town Hall, ____.'

Belfast	Dublin	Londonderry
Cork	Limerick	Waterford

COUNTY AND COUNTY BOROUGH COUNCILS WITH INDEX MARKS

England and Wales

County	Index mark	County	Index mark
Counties:		Counties (*cont.*):	
Anglesey	E.Y.	Peterborough, Soke of	F.L.
Bedfordshire	B.M.	Radnorshire	F.O.
Berkshire	B.L.	Rutland	F.P.
Breconshire	E.U.	Salop	A.W.
Buckinghamshire	B.H.	Somerset	Y.
Cambridgeshire	C.E.	Southampton [1]	A.A.
Cardiganshire	E.J.	Staffordshire	E.
Carmarthenshire	B.X.	Suffolk, East	B.J.
Carnarvonshire	C.C.	Suffolk, West	C.F.
Cheshire	M.	Surrey	P.
Cornwall	A.F.	Sussex, East	A.P.
Cumberland	A.O.	Sussex, West	B.P.
Denbighshire	C.A.	Warwickshire	A.C.
Derbyshire	R.	Westmoreland	E.C.
Devonshire	T.	Wight, Isle of	D.L.
Dorset	B.F.	Wiltshire	A.M.
Durham	J.	Worcestershire	A.B,
Ely, Isle of	E.B.	Yorkshire, East Riding	B.T.
Essex	F.	Yorkshire, North Riding	A.J.
Flintshire	D.M.	Yorkshire, West Riding	C.
Glamorganshire	L.	County Boroughs:	
Gloucestershire	A.D.	Barrow-in-Furness	E.O.
Herefordshire	C.J.	Bath	F.B.
Hertfordshire	A.R.	Birkenhead	C.M.
Huntingdonshire	E.W.	Birmingham	O.
Kent	D.	Blackburn	C.B.
Lancashire	B.	Bolton	B.N.
Leicestershire	A.Y.	Bootle	E.M.
Lincolnshire, Parts of Holland	D.O.	Bournemouth	E.L.
Lincolnshire, Parts of Kesteven	C.T.	Bradford (Yorkshire)	A.K.
Lincolnshire, Parts of Lindsey	B.E.	Brighton	C.D.
London	A.	Bristol	A.E.
Merioneth shire	F.F.	Burnley	C.W.
Middlesex	H.	Burton-upon-Trent	F.A.
Monmouthshire	A.X.	Bury	E.N.
Montgomeryshire	E.P.	Canterbury	F.N.
Norfolk	A.H.	Cardiff	B.O.
Northamptonshire	B.D.	Chester	F.M.
Northumberland	X.	Coventry	D.U.
Nottinghamshire	A.L.	Croydon	B.Y.
Oxfordshire	B.W.	Derby	C.H.
Pembrokeshire	D.E.	Devonport	D.R.
		Dudley	F.D.
		Exeter	F.J.
		Gateshead	C.N.

[1] Southampton = Hampshire [Ed.].

ENGLAND AND WALES (*continued*)

County	Index mark	County	Index mark
COUNTY BOROUGHS (*cont.*):		COUNTY BOROUGHS (*cont.*):	
Gloucester	F.H.	Portsmouth	B.K.
Great Yarmouth	E.X.	Preston	C.K.
Grimsby	E.E.	Reading	D.P.
Halifax	C.P.	Rochdale	D.K.
Hanley	E.H.	Rotherham	E.T.
Hastings	D.Y.	St. Helens	D.J.
Huddersfield	C.X.	Salford	B.A.
Ipswich	D.X.	Sheffield	W.
Kingston-upon-Hull	A.T.	Southampton	C.R.
Leeds	U.	South Shields	C.U.
Leicester	B.C.	Stockport	D.B.
Lincoln	F.E.	Sunderland	B.R.
Liverpool	K.	Swansea	C.Y.
Manchester	N.	Walsall	D.H.
Middlesbrough	D.C.	Warrington	E.D.
Newcastle-upon-Tyne	B.B.	West Bromwich	E.A.
Newport (Monmouth)	D.W.	West Ham	A.N.
Northampton	D.F.	West Hartlepool	E.F.
Norwich	C.L.	Wigan	E.K.
Nottingham	A.U.	Wolverhampton	D.A.
Oldham	B.U.	Worcester	F.K.
Oxford	F.C.	York	D.N.
Plymouth	C.O.		

The regulations for Scotland and Ireland are practically identical with those for England and Wales, the regulations having been settled finally at a conference of representatives of the Local Government Boards for England and Wales and Ireland and the Scottish Office. The following is, however, a list of the Index Marks for the various authorities in Scotland and Ireland, with the Index Marks assigned to them :—

SCOTLAND

County	Index mark	County	Index mark
COUNTY COUNCILS :		COUNTY COUNCILS (*cont.*):	
Aberdeen	SA	Inverness	ST
Argyll	SB	Kincardine	SU
Ayr	SD	Kinross	SV
Banff	SE	Kirkcudbright	SW
Berwick	SH	Lanark	V
Bute	SJ	Linlithgow	SX
Caithness	SK	Midlothian	SY
Clackmannan	SL	Nairn	AS
Dumfries	SM	Orkney	BS
Dumbarton	SN	Peebles	DS
Elgin	SO	Perth	ES
Fife	SP	Renfrew	HS
Forfar	SR	Ross and Cromarty	JS
Haddington	SS	Roxburgh	KS

Scotland (*continued*)

County	Index mark	County	Index mark
County Councils (*cont.*):		Town Councils (*cont.*):	
Selkirk	LS	Dundee	TS
Stirling	MS	Edinburgh	S
Sutherland	NS	Glasgow	G
Wigtown	OS	Govan	US
Zetland	PS	Greenock	VS
		Leith	WS
Town Councils:		Paisley	XS
Aberdeen	RS	Partick	YS

Ireland

County	Index mark	County	Index mark
County Councils:		County Councils (*cont.*):	
Antrim	IA	Mayo	IZ
Armagh	IB	Meath	AI
Carlow	IC	Monaghan	BI
Cavan	ID	Queen's County	CI
Clare	IE	Roscommon	DI
Cork	IF	Sligo	EI
Donegal	IH	Tipperary, N. Riding	FI
Down	IJ	Tipperary, S. Riding	HI
Dublin	IK	Tyrone	JI
Fermanagh	IL	Waterford	KI
Galway	IM	Westmeath	LI
Kerry	IN	Wexford	MI
Kildare	IO	Wicklow	NI
Kilkenny	IP	County Boroughs:	
King's County	IR	Belfast	OI
Leitrim	IT	Cork	PI
Limerick	IU	Dublin	RI
Londonderry	IW	Limerick	TI
Longford	IX	Londonderry	UI
Louth	IY	Waterford	WI

THE MOTOR CAR (USE AND CONSTRUCTION) ORDER

TEXT OF THE NEW ORDER

The Local Government Board have now issued the Use and Construction Order under the Motor Car Act, 1903, which has been under consideration for some time. The original draft Order was, it will be remembered, submitted to the A.C.G.B. and I. and the Motor Union for suggestions as to any amendments that might be desirable, and it is gratifying to note that nearly all the suggestions put forward have been adopted. The Order, as

given below, is accompanied by the following circular letter to the Local Authorities :—

Local Government Board, Whitehall, S.W.,
March 10th, 1904

Sir,—I am directed by the Local Government Board to forward for the information of the Council two copies of an Order which they have issued under the Motor Car Acts, 1896 and 1903, prescribing Regulations with respect to the use of motor cars on highways, and their construction and the conditions under which they may be used. These Regulations do not increase the legal weight of motor cars, and they therefore apply solely to mechanically-propelled vehicles weighing less than three tons unladen (or with a trailer, four tons), and otherwise conforming to the definition of light locomotive in Section 1 of the Act of 1896.

They repeal and take the place of the series of Regulations made under the Act of 1896 and contained in the Order of November 9th, 1896. In many respects the new Regulations follow the old, but there are a certain number of changes to which attention may be drawn.

Thus, under the Regulations of 1896 the maximum width of a motor car between its extreme projecting points was 6 ft. 6 in. This width is now increased to 7 ft. 2 in.

The provisions with regard to lamps on motor cars have undergone some modifications. The Order of 1896 required each car to carry a lamp on the extreme offside, showing by night white in front and red behind. A lamp is still required in this position showing white in front, but the new Order provides that if there is a lamp on the back of the car which exhibits a red light behind the car the other requirement as to the red light need not be observed. The lamps on motor cycles remain, as heretofore, regulated by Section 85 of the Local Government Act, 1888.

A new provision is included in the Order prohibiting the use of searchlights on motor cars, as the moving beam from these lights is found to be very alarming to horses on a highway.

Complaints have been made of the danger and annoyance caused by very bright and dazzling lamps which are carried at night on some motor cars. The matter has been carefully considered, but the Board have not seen their way at present to a satisfactory Regulation on the subject. They will continue to give attention to the question, but they trust that motorists will take such action as to avoid this cause of complaint, and so render a regulation on the subject unnecessary.

The question of speed is not touched by these Regulations. Section 12 (2) of the Act of 1903 gives the Board power to make regulations as to the speed of motor cars weighing unladen more than two tons; but for the present the Board propose to leave the matter of speed to be dealt with under the provisions of the Act. It must not be supposed that the Board contemplate that vehicles over two tons in weight ought to travel at a rate approaching twenty miles an hour, the maximum fixed by the Act, but, unless it should hereafter be found advisable to lay down a definite speed limit in these cases, they would prefer to avoid doing so, and (subject to any regulations as to particular highways and places which may be made) to rely on the provisions in Section 1 (1), which makes it an offence under the Act to drive a motor car on a public highway at a speed which is dangerous to the public.

The Order contains in Article III. some regulations relating to vehicles drawn by motor cars, but no serious restriction is imposed on light trailers such as are frequently attached to motor cycles.

The provisions of Article IV. are, with slight modifications, reproductions of provisions in the earlier Regulations.

Article V. is intended to check the excessive noise which is sometimes

caused by the engines of a motor car being continued in motion while the car is stationary.

The question of increasing the weight of motor cars, under Section 12 of the Act of 1903, is under investigation by a Departmental Committee. It is possible that the result of their inquiry may be to show the advisability of modifying some of the provisions of the present Order; but the Board have thought it undesirable to postpone its issue further on that account.

In their circular letter of the 20th November, 1903 (addressed to Councils of Counties and County Boroughs) the Board referred to the question of the notices and signposts which Local Authorities are authorised to erect under Section 10 of the Act of 1903. They are informed that the County Councils Association and the Municipal Corporations Association have proposed some uniform symbols for use for the purposes of these notices and signposts. The proposals of the Associations are shown in the Appendix to this Circular, and it appears to the Board that they might conveniently be adopted. The Board are empowered, so far as signposts under Section 10 (2) are concerned, to make regulations prescribing the size and colour of such posts; but their power is limited to this. If, however, the recommendations of the Associations are carried out, it seems to the Board to be unnecessary for them to issue regulations on the subject.

The Order and this Circular will be placed on sale, and copies may shortly be obtained, either directly or through any bookseller, from Messrs. Eyre and Spottiswoode, East Harding-street, Fleet-street, E.C. The Circular Letter of the 20th November, 1903, above referred to, is also on sale in like manner.

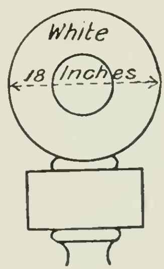
I am, Sir, Your obedient Servant,

S. B. Provis, *Secretary.*

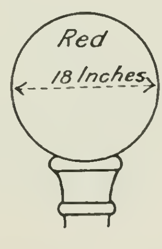
Appendix

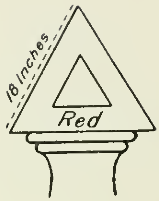
Recommendations for notices and signposts under Section 10 of the Motor Car Act, 1903, adopted by the County Councils Association and the Municipal Corporations Associations:—

I. For 10 mile or lower limit of speed, a white ring, 18 in. in diameter, with plate below, giving the limit in figures.

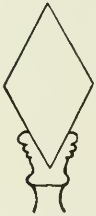


II. For prohibition, a solid red disc, 18 in. in diameter.





III. For caution (dangerous corners, cross roads, or precipitous places), a hollow red equilateral triangle, with 18 in. sides.



IV. All other notices under the Act to be on diamond-shaped boards.

That all such notices be placed on the near side of the road, facing the approaching driver.

That all notices under Section 10 (2) of the Act be fixed at about 50 yards from the spot to which they apply.

That the under-side of the sign be not less than 8 ft. from the ground level.

REGULATIONS (USE AND CONSTRUCTION OF MOTOR CARS).—GENERAL

Now therefore, in pursuance of the powers given to Us by the Act of 1896 and the Act of 1903, and by any other Statutes in that behalf, We, the Local Government Board, Do hereby rescind the said Regulations made by Our Order dated the Ninth day of November, One thousand eight hundred and ninety-six, and do by this Our Order make the following Regulations with respect to the use of motor cars on highways, and their construction, and the conditions under which they may be used :—

ARTICLE I.—In this order—

The expression 'carriage' includes a wagon, cart, or other vehicle.

The expression 'horse' includes a mule or other beast of draught or burden, and the expression 'cattle' includes sheep.

The expression 'motor car' means a vehicle propelled by mechanical power which is under three tons in weight unladen, and is not used for the purpose of drawing more than one vehicle (such vehicle with its locomotive not exceeding in weight unladen four tons), and is so constructed that no smoke or visible vapour is emitted therefrom except from any temporary or accidental cause.

In calculating for the purposes of this Order the weight of a vehicle unladen, the weight of any water, fuel, or accumulators used for the purpose of propulsion shall not be included.

The expression 'highway' includes any roadway to which the public are granted access.

Article II.—No person shall cause or permit a motor car to be used on any highway, or shall drive or have charge of a motor car, when so used, unless the conditions hereinafter set forth are satisfied; namely:—

(1.) The motor car, if it exceeds in weight unladen five hundredweight, shall be capable of being so worked that it may travel either forwards or backwards.

(2.) The motor car shall not exceed seven feet two inches in width, such width to be measured between its extreme projecting points.

(3.) The tyre of each wheel of the motor car shall be smooth, and shall, where the same touches the ground, be flat, and of the width following, namely:—

(*a*) If the weight of a motor car unladen exceeds fifteen hundredweight, but does not exceed one ton, not less than two and a half inches;

(*b*) If such weight exceeds one ton, but does not exceed two tons, not less than three inches;

(*c*) If such weight exceeds two tons, but does not exceed three tons, not less than four inches.

Provided that where a pneumatic tyre, or other tyre of a soft or elastic material, is used, the conditions hereinbefore set forth with respect to tyres shall not apply.

(4.) The motor car shall have two independent brakes in good working order, and of such efficiency that the application of either to the motor car shall cause two of its wheels on the same axle to be so held that the wheels shall be effectually prevented from revolving, or shall have the same effect in stopping the motor car as if such wheels were so held.

Provided that in the case of a motor car having less than four wheels this condition shall apply as if, instead of two wheels on the same axle, one wheel was therein referred to.

(5.) Where the weight of a motor car unladen exceeds fifteen hundredweight and the motor car is fitted with tyres other than pneumatic tyres or tyres of a soft or elastic material, the weight of the motor car unladen shall be painted in one or more straight lines upon some conspicuous part of the right or off side of the motor car in large legible letters in white upon black or black upon white, not less than one inch in height.

(6.) The motor car and all the fittings thereof shall be in such a condition as not to cause, or to be likely to cause, danger to any person on the motor car or on any highway.

(7.)—(i.) The lamp to be carried attached to the motor car in pursuance of Section 2 of the Act of 1896 shall be so constructed and placed as to exhibit, during the period between one hour after sunset and one hour before sunrise, a white light visible within a reasonable distance in the direction towards which the motor car is proceeding or is intended to proceed, and to exhibit a red light so visible in the reverse direction. The lamp shall be placed on the extreme right or off side of the motor car in such a position as to be free from all obstruction to the light.

Provided that where a lamp, which exhibits a red light in the direction contrary to that towards which the motor car is proceeding, is carried attached at the back of the motor car, the Condition requiring the lamp attached in pursuance of Section 2 of the Act of 1896 to exhibit a red light shall not apply or have effect with regard to the motor car.

Provided also that the first paragraph of this Condition shall not extend to any bicycle, tricycle, or other machine to which Section 85 of the Local Government Act, 1888, applies.

(ii.) Every lamp carried by the motor car when in use on a highway at any time during the period mentioned in this Condition shall be so constructed, fitted, and attached as to prevent the movement or the use as a searchlight of the light exhibited by any such lamp.

Article III.—No person shall cause or permit a motor car to be used on

any highway for the purpose of drawing any vehicle, or shall drive or have charge of a motor car when used for such purpose, unless the Conditions hereinafter set forth are satisfied ; namely—

(1.) Conditions (2), (3), (5), and (6) of Article II. of this Order shall apply as if the vehicle drawn by the motor car was therein referred to instead of the motor car itself.

(2.) Every vehicle exceeding two hundredweight in weight unladen, drawn by a motor car, shall have a brake in good working order of such efficiency that its application to the vehicle shall cause two of the wheels of the vehicle on the same axle to be so held that the wheels shall be effectually prevented from revolving, or shall have the same effect in stopping the vehicle as if such wheels were so held.

(3.) The vehicle drawn by a motor car shall, when in pursuance of the Condition lastly hereinbefore set forth a brake is required to be attached thereto, carry upon the vehicle a person competent to apply efficiently the brake : Provided that it shall not be necessary to comply with this Condition if the brakes upon the motor car by which the vehicle is drawn are so constructed and arranged that neither of such brakes can be used without bringing into action simultaneously the brake attached to the vehicle drawn, or if the brake of the vehicle drawn can be applied from the motor car by a person upon the motor car independently of the brakes of the latter.

Article IV.—Every person driving or in charge of a motor car when used on any highway shall comply with the regulations hereinafter set forth ; namely—

(1.) He shall not cause the motor car to travel backwards for a greater distance or time than may be requisite for the safety or convenience of the occupants of the motor car and of the passenger and other traffic on the highway.

(2.) He shall not, when on the motor car, be in such a position that he cannot have control over the same, or that he cannot obtain a full view of the road and traffic ahead of the motor car, or quit the motor car without having taken due precautions against its being started in his absence, or allow the motor car or a vehicle drawn thereby to stand on such highway so as to cause any unnecessary obstruction thereof.

(3.) He shall when meeting any carriage, horse, or cattle, keep the motor car on the left or near side of the road, and when passing any carriage, horse, or cattle, proceeding in the same direction, keep the motor car on the right or off side of the same.

(4.) He shall not negligently or wilfully prevent, hinder, or interrupt the free passage of any person, carriage, horse, or cattle, on any highway, and shall keep the motor car and any vehicle drawn thereby on the left or near side of the road for the purpose of allowing such passage.

(5.) He shall, whenever necessary, by sounding the bell or other instrument required by Section 3 of the Act of 1896, give audible and sufficient warning of the approach or position of the motor car.

(6.) He shall on the request of any police constable in uniform, or of any person having charge of a horse, or if any such constable or person shall put up his hand as a signal for that purpose, cause the motor car to stop and to remain stationary so long as may be reasonably necessary.

Article V.—Every motor car shall be so constructed as to enable the driver, when the motor car is stationary otherwise than through an enforced stoppage owing to necessities of traffic, to stop the action of any machinery attached to or forming part of the motor car so far as may be necessary for the prevention of noise. The driver shall on every such occasion make prompt and effective use of all such means as, in pursuance of this Condition, are provided for the prevention of noise as above-mentioned.

Provided that this regulation shall not apply so as to prevent the examination or working of the machinery attached to, or forming part of a motor car where any such operation is rendered necessary by any failure or derangement of the said machinery.

This Order may be cited as 'The Motor Cars (Use and Construction) Order, 1904.'

Given under the Seal of Office of the Local Government Board, this Ninth day of March, in the year One thousand nine hundred and four.

WALTER H. LONG, *President*.

S. B. PROVIS, *Secretary*.

THF KEEPING AND USE OF PETROLEUM

REGULATIONS DATED MARCH 18TH, 1903, MADE BY THE SECRETARY OF STATE UNDER SECTION 5 OF THE LOCOMOTIVES ON HIGHWAYS ACT, 1896, AS TO THE KEEPING AND USE OF PETROLEUM FOR THE PURPOSES OF LIGHT LOCOMOTIVES

LOCOMOTIVES ON HIGHWAYS ACT, 1896 (59 AND 60 VICT. C. 36, S. 5)

In promulgating the following Regulations relating to the keeping, conveyance, and use of petroleum in connection with light locomotives, the Secretary of State for the Home Department desires to direct public attention to the dangers that may arise from the careless use of the more volatile descriptions of petroleum, commonly known as petroleum spirit. Not only is the vapour therefrom, which is given off at ordinary temperatures, capable of being easily ignited, but it is also capable, when mixed with air, of forming an explosive atmosphere. It is therefore necessary, in dealing with and handling the spirit, to take strict precautions by the employment of thoroughly sound and properly closed vessels, and by avoiding the use of naked lights in dangerous proximity, to prevent leakage of the spirit and the contact of any form of artificial light with the highly inflammable vapour which it is always evolving.

REGULATIONS.—By virtue of the powers conferred on me by the Fifth Section of the Locomotives on Highways Act, 1896, I hereby make the following Regulations for the keeping and use of petroleum for the purposes of light locomotives.

In these regulations the expression 'petroleum spirit' shall mean the petroleum to which the Petroleum Acts, 1871 and 1879, apply, provided that when any petroleum other than that to which the said Petroleum Acts apply, is on or in any light locomotive, or is being conveyed or kept in any place on or in which there is also present any petroleum spirit as above defined, the whole of such petroleum shall be deemed to be petroleum spirit.

In these Regulations the expression 'storehouse' shall mean any room, building, coach-house, lean-to, or other place in which petroleum spirit for the purposes of light locomotives is kept in pursuance of these Regulations.

1. The following shall be exempt from licence under the Petroleum Act, 1871, namely :—
   - (*a*) Petroleum spirit which is kept for the purpose of, or is being used on, light locomotives when kept or used in conformity with these regulations.
   - (*b*) Petroleum spirit which is kept for the purpose of, or is being used on, light locomotives by. or by authority of, one of his Majesty's Principal Secretaries of State, the Admiralty, or other department of the Government, and which is subject to special regulations.
2. These Regulations shall apply to petroleum spirit which is kept for the

purpose of, or is being used on, light locomotives, and for which (save as hereinafter provided) no licence has been granted by the Local Authority under the Petroleum Act, 1871, and shall not apply to petroleum spirit which is kept for sale, or partly for sale and partly for use on light locomotives, and which must be kept in accordance with the provisions of the Petroleum Acts as heretofore.

3. Where for any special reason a person keeping petroleum spirit for the purpose of light locomotives applies for a licence under the Petroleum Acts, 1871, and the Local Authority see fit to grant such licence, such petroleum spirit shall be subject only to Regulations 8 to 13, and the conditions of such licence, in so far as the said conditions are not contrary to the said Regulations 8 to 13.

4. Where a storehouse forms part of, or is attached to, another building, and where the intervening floor or partition is of an unsubstantial or highly inflammable character, or has an opening therein, the whole of such building shall be deemed to be the storehouse, and no portion of such storehouse shall be used as a dwelling or as a place where persons assemble. A storehouse shall have a separate entrance from the open air distinct from that of any dwelling or building in which persons assemble.

5. The amount of petroleum spirit to be kept in any one storehouse, whether or not upon light locomotives, shall not exceed sixty gallons at any one time.

6. Where two or more storehouses are in the same occupation, and are situated within 20 ft. of one another, they shall, for the purposes of these Regulations, be deemed to be one and the same storehouse, and the maximum amount of petroleum spirit prescribed in the foregoing regulation shall be the maximum to be kept in all such storehouses taken together. Where two or more storehouses in the same occupation are distant more than 20 ft. from one another the maximum amount shall apply to each storehouse.

7. Any person who keeps petroleum spirit in a storehouse which is situated within 20 ft. of any other building whether or not in his occupation, or of any timber stack or other inflammable goods not owned by him, shall give notice to the local authority under the Petroleum Acts for the district in which he is keeping such petroleum spirit, that he is so keeping petroleum spirit, and shall renew such notice in the month of January in each year during the continuance of such keeping, and shall permit any duly authorised officer of the local authority to inspect such petroleum spirit at any reasonable time. This Regulation shall not apply to petroleum spirit kept in a tank forming part of a light locomotive.

8. Every storehouse shall be thoroughly ventilated.

9. Petroleum spirit shall not be kept, used, or conveyed except in metal vessels so substantially constructed as not to be liable, except under circumstances of gross negligence or extraordinary accident, to be broken or become defective or insecure. Every such vessel shall be so constructed and maintained that no leakage, whether of liquid or vapour, can take place therefrom.

10. Every such vessel, not forming part of a light locomotive, when used for conveying or keeping petroleum spirit shall bear the words 'petroleum spirit highly inflammable' legibly and indelibly stamped or marked thereon, or on a metallic or enamelled label attached thereto, and shall be of a capacity not exceeding two gallons.

11. Before repairs are done to any such vessel, that vessel shall, as far as practicable, be cleaned by the removal of all petroleum spirit and of all dangerous vapours derived from the same.

12. The filling or replenishing of a vessel with petroleum spirit shall not be carried on, nor shall the contents of any such vessel be exposed in the presence of fire or artificial light, except a light of such construction, position, or character as not to be liable to ignite any inflammable vapour arising from such spirit, and no fire or artificial light capable of igniting inflammable vapour

shall be brought within dangerous proximity of the place where any vessel containing petroleum spirit is being kept.

13. In the case of all petroleum spirit kept or conveyed for the purpose of, on in connection with, any light locomotive, (*a*) all due precautions shall be taken for the prevention of accidents by fire or explosion, and for the prevention of unauthorised persons having access to any petroleum spirit kept or conveyed, and to the vessels containing or intended to contain, or having actually contained, the same; and (*b*) every person managing, or employed on, or in connection with any light locomotive shall abstain from every act whatever which tends to cause fire or explosion, and which is not reasonably necessary, and shall prevent any other person from committing such act.

14. These Regulations shall come into operation on the 18th day of March, 1903, from which date the Regulations dated 3rd November, 1896, and the 26th day of April, 1900, are hereby repealed.

A. Akers-Douglas,

One of His Majesty's Principal Secretaries of State.

Whitehall, S.W., 18th March, 1903.

Note.—From the above Regulations it will be seen that there are two methods in which petroleum spirit required for use in motor cars may be kept. The first of these will be the usual method, namely, to keep in accordance with these Regulations ; but where a person finds that for some special reason he cannot observe one of the Regulations 4, 5, or 6, he may resort to the second method, namely, to apply to the Local Authority for a licence. In such cases the place will be examined by the Local Authority Officer, who will advise the Local Authority as to its suitability for licence. Where a licence has been granted Regulations 4 to 7 no longer apply.

In no case is petroleum spirit kept wholly or partly for sale exempt from the necessity of a licence.

GLOSSARY OF TERMS USED IN AUTOMOBILISM

FRENCH—GERMAN—ENGLISH

Abaissement, Erniedrigung, **depression, diminution.**

Abaisser, niedriger machen, **to lower.**

About, Stoss, **end, butt.**

Acier, Stahl, **steel.**

Acier à outils, Gerätstahl, **tool steel.**

Acier doux, weicher Stahl, **mild steel.**

Acier fondu, acier coulé, Gussstahl, **cast steel.**

Acier trempé, **tempered steel.**

Accélérateur, Beschleuniger, **accelerator.**

Accélérateur à levier, Hebelbeschleuniger, **lever accelerator.**

Accélérateur à pédale, Fussbeschleuniger, **pedal accelerator.**

Accélération, Beschleunigung, **acceleration.**

Accident, panne, Unfall, **accident.**

Accouplement, Kuppelung, Wellenkuppelung, **coupling.**

Accouplement (manchon d'), Muffenkupplung, **coupling box.**

Accumulateur, Accumulator, Sammler, **accumulator.**

Adhérence, Adhäsion, **adhesion.**

Admission, Einlass, Einflusz, **inlet.**

Admission (soupape d'), Saugventil, **inlet valve.**

Aiguille, Nadel, **needle, pricker.**

Aiguille à passer, Nadel, **bodkin.**

Aile, Flügel, **vane, leaf, wing.**

Aile d'hélice, Schraubenflügel, **blade of screw propeller.**

Ailette, Zapfen, **wing, flange.**

Ajutage, Düse, **nozzle.**

Alcool, Alkohol, **alcohol.**

Alésage, Nachbohren, **reaming, bore of a cylinder.**

Alène, Ahle, **awl.**

Aléser, ausdrehen, **to bore.**

Alésoir, Reibahle, **reamer.**

Alimentation, Speisung, **feed, supply.**

Alléger, erleichtern, **to thin, to reduce the (weight of something).**

Alliage, Legierung, **alloy.**

Allonger, **to lengthen.**

Allumage, Zündung, **ignition, firing.**

- *électrique*, electrischezündung, **electric.**
- *avance, à l'*, Vorauszündung, **advance.**
- *retard, à l'*, Verzugzündung, **retard.**
- *par tube*, Glühröhrenzündung, **tube.**
- *raté d'*, **missfire.**
- *appareil d'*, Zündungsvorrichtung, **ignition apparatus.**
- *boîte d'*, Zündgehäuse, **ignition box.**
- *bobine d'*, Zündspule, **ignition coil.**

Allumeur, Zünder, **igniter, primer.**

- *régulation de l'allumateur*, Verstellung der Zündung, Einstellung des Zündzeitspunkts.

Allure, Gang, **speed, pace.**

Amarrage, sorring, **lashing, fastening.**
Amiante, Asbest, **asbestos.**
Amorçage (*moteur*), Zündung, **priming.**
Amortisseur, Dämpfungsvorrichtung, **damper, dash-pot.**
Angle, Winkel, **angle.**
Angle droit, rechter Winkel, **right angle.**
Angle (*roue d'*), Kegelrad, **bevel wheel.**
Anneau, Ring, **ring, hoop.**
Anneau de chaîne, Gelenk, Kettenschlussglied, **link.**
Anneau de chaîne de rechange, Reserve-Kellenschlussglied, **spare link.**
Appareil, Apparat, Vorrichtung, **apparatus.**
Appareil d'alimentation, Wasserzuleitung, Zufuhr, **feed apparatus.**
Appareil de détente, Expansions-Steuerung, **expansion gear.**
Arbre, Welle, **shaft, axletree.**
Arbre à came, Daumenwelle, **camshaft**; Steuerwelle, **kicking shaft.**
Arbre à vilebrequin à manivelles, arbre coudé, Kurbelwelle, **crank shaft.**
Arbre carré, Viereckigwelle, **square shaft.**
Arbre de frein, Bremswelle, **brake shaft.**
Arbre d'embrayage, Kupplungswelle, **clutch shaft.**
Arbre de relevage, Steuerwelle, **reversing shaft, half-speed shaft.**
Arbre intermédiaire, Vorgelegewelle, **intermediary shaft, countershaft.**
Arbre moteur, de couche, Treibwelle, **main shaft.**
Armature, Anker, **armature.**
Arrière, hinter, **astern, backward.**
Aspiration, Ansäugen, **suction, intake.**
Assemblage, Verbindung, **joint.**
Atelier, Werkstätte, **workshop, factory**
Attelage, Bespannung, Zug, **team.**
Attelage (*chaîne d'*), Zugkette, **coupling chain.**
Aubes (*roue à*), Schaufel, **paddle-wheel.**
Avance (*angle d'*), Voreilwinkel, **angle of lead.**
Avant, en, Vorwärts, **ahead, forward.**
Avarie, panne, Havarie, **damage, breakdown.**
Axe, Achse, **axis, shaft.**
Axe de manivelle, Kurbelachse, **crank shaft.**
Axe ou essieu moteur, Treibachse, **driving shaft.**

Bâche, Teertuch, **tarpaulin.**
Bâche, Brunnen, **hot-well, tank.**
Bague, Stossring, **ring.**
Baille, Eimer, **bucket, tub, feed tank.**
Balai, Bürste, **brush.**
Balancier, Balancier, **beam.**
Bandage, bande, Radreifen, **tyre.**
Banlieue, Vorstadt, **suburbs.**
Baquet, Eimer, **bucket.**
Barillet, Pumpenstiefel, **barrel (pump), small barrel, keg.**
Basse pression, Niederdruck, **low pressure.**
Barbotage (*des manivelles*), **splashing in lubricating bath, in crank pit.**
Bâti, Gestell, **frame, bed plate.**
Batterie, Batterie, **battery.**
Bec, Brenner, **burner, jet.**
Béquille, Hemmenstange, **devil drag, sprag.**
Bidon, Kanne, Dose, **can** (small).
Bielle, Kurbelstange, **connecting rod.**
Bielle de tiroir, Schieberstange, **valve-rod.**
Bille, Kugel, **ball.**
Blanc de céruse, Bleiweiss, **white lead.**

Blindage en fer, Eisenblech, **iron sheeting.**
Bloc, de frein, Bremseklotz, **brake block.**
Bobine, Spule, **coil.**
Bobine de résistance, Widerstandsspule, **resistance coil.**
Bobine de Rhumkorf, Funkeninductor, Zündspule, **sparking coil.**
Bois, Holz, **wood, timber.**
Boîte d'allumage, Zündgehäuse, **burner box, ignition box.**
Boîte à tiroir, Schieberkasten, **slide valve chest.**
Boîte à feu, Feuerung, **fire box.**
Borne, Drahtklemme, **terminal, binding screw.**
Bosselé, hökerig, **battered, bruised.**
Bouche, Öffnung, **orifice.**
Bouchon, Giessstopfen, **plug.**
Boucle, Schleife, **loop.**
Boue, Schmutz, **mud.**
Bougie d'allumage, Zündkerze, **sparking plug.**
Boule, Kegel, **ball, knob.**
Boulon, Bolzen, Schraubbolzen, **bolt pin.**
Boulon de fondation, Befestigungschraube, **holding down bolts.**
Bont du moyeu, Nabenende, **end of the nave.**
Braquement, Steuerungwinkel, **steering angle, lock.**
Bras, Arm, **arm, crank, web.**
Braser, hartlöthen, **to braze.**
Bride, Verbindung, **flange, bridge, clip.**
Broche, Spindel, Dorn, **spindle, pin.**
Broche, Spiess, **broach, tommy.**
Brouette, Schubkarren, **wheelbarrow.**
Bruit, Geräusch, **noise.**
Brûler, verbrennen, **to burn.**
Brûleur, Brenner, **burner.**
Brûleur (chalumeau de), Brenner, **burner, stem.**
Brûleur (lanterne de), Brennerkasten, **burner box.**
Brûleur (manchon de), Brennerhülse, **burner mantle.**
Brume, Nebel, **fog, haze.**
Burette, Kanne, **can** (large).
Burin, Meissel, **cold chisel.**
Buse, Wetterloch, **nozzle.**
Butée, Stutz, **stop.**
Butoir, Mitnehmer, **triprod, kicker.**

Câble de remorque, Bugsierseile, **tow rope.**
Cadran, Zifferblatt, **dial.**
Cadre, Rahmen, **frame.**
Caisse, Kasten; Wagenkasten, **chest, box, case, body.**
Caisse, à eau, Wassertank, **water-tank.**
Cale, Unterlage, **wedge.**
Caler, **to prop, to scotch.**
Calibre, gabarit, Lehre, **template.**
Came, Daumen, **cam, tappet, lifter, kicker.**
Camion, Frachtwagen, Lastwagen, **heavy four-wheeled waggon, lorry, truck.**
Caniveau, Rinne, **the gutter formed by a roadway and the adjoining kerb.**
Caoutchouc, Gummi, **indiarubber.**
Capote, Verdeck, **hood.**
Carne, Kante, **edge.**
Carneaux de chaudière, Feuerzugesse, **boiler flues.**
Carré, Quadrat, **square.**
Carrefour, Kreuzweg, **road crossing.**
Carrossage (d'une roue), Sturtz, Achsenkelsturtz, **dishing of a wheel.**
Carrosserie, Wagenwerk, **carriage work.**
Carte, Karte, **map.**
Carter, Gehäuse, **casing, gear case, base chamber.**
Cassure, Bruch, **fracture.**
Cendre, Asche, **ash.**
Cendrier, Achsenkasten, **ashpit.**
Cercle primitif, Theilkreis, **pitch circle.**
Céruse, Bleiweiss, **white lead.**

Chaîne à la Vaucanson, Vaucanson'sche Kette, **pitch-chain.**
Chaîne à rouleaux, Rollenkette, **roller chain.**
Chalumeau, Löthrohr, **blowpipe.**
Chambre des manivelles, **crank-chamber.**
Changement de marche, Umsteuerung, **reversing gear.**
Changement de vitesse, Geschwindigkeitsänderung, Wechselgetriebe, **change of speed.**
Chapeau (palier), Kappe, Deckel, (Lager), **cap piece, bearing.**
Chapeau de moyeu, Achsenkappe, **axle cap.**
Charbon, Kohle, **charcoal or coal.**
Charge, Belastung, **load.**
Charnière, Scharnier, Hespe, **hinge, joint.**
Charpente, Zimmerwerk, **timber work or framing.**
Châssis, Untergestell, **underframe.**
Chaudière, chaudronnier, Dampfkessel, Kesselmacher, **steam boiler, boiler maker.**
Chauffage d'un essieu ou d'un coussinet, Warmlaufen einer Achse, **running hot of an axle or a bearing.**
Chaussée, Kunststrasse, **highway.**
Cheminée, Schornstein, **chimney, smoke stack.**
Chemise, Kleidung, **jacket.**
Chêne, Eiche, **oak.**
Cheville, Schlussnagel, **pin, peg, bolt, plug.**
Cheville ouvrière, Reihnagel, **fore-pin, of fifth wheel of a carriage.**
Chicane, **baffle plate.**
Cintré, gebogen, **bent.**
Circulation (pompe de), Druckpumpe, **circulation pump.**
Clapet, Klappventil, **valve clack.**
Clavette, Keil, **key, feather.**
Clef, Schlüssel, **spanner, monkey wrench.**
Cliquet, Sperre, **pawl.**
Coincement, Festdrückung, **wedging, jamming, binding.**
Col de cygne, Schwanenhals, **gooseneck.**
Collet, Rand, **neck, collar.**
Collier, frette, collet, Hülse, **collar.**
Collier d'excentrique, Excentrikreifen, **excentric strap.**
Collision, choc, Stoss, **impact.**
Commande, Getriebe, **transmission.**
Commutateur, Kommutator, Umschalter, **commutator, two-way switch.**
Compteur, Messapparat, **counter, meter.**
Cone, Conus, **cone, taper.**
Contact (par frottement), Reibungskontakt, **rubbing contact.**
Contre-écrou, Gegenmutter, **lock nut, check nut.**
Contre-poids, Gegengewicht, **counterweight, balance weight.**
Coquille, Schale, **shell.**
Cordage, Corde, Strick, **rope.**
Cornière, Winkeleisen, **angle iron.**
Côté, Seite, **side.**
Coude, Krummer, **elbow.**
Coulisse, Falz, **channel or groove.**
Coulisse de Stephenson, Stephenson'sche Coulissensteuerung, **Stephenson's link motion.**
Coulisseau, Gleitbacken, **slideblock, crosshead.**
Couper, schneiden, **to cut.**
Couple, Drehmoment, **torque, coupling chain.**
Courant, Strom, **current.**
Courbé, gebogen, **bent.**
Couronne, Kettenrad, **sprocket wheel.**
Courroie, Riemen, **belt, strap.**
Course, Fernfahrt, **race.**
Course de piston, Kolbenhub, **piston stroke.**
Court circuit, Kurzschluss, **short circuit.**
Coussinet, Lager, **bush-bearing.**
Couvre-joint, Stossfuge, **butt joint.**
Cracher, **electric mach., to spark**

(brushes); gas engines, to fire back.

Crémaillère, Zahnstange, **rack.**

Creux, Höhlung, **hollow, depth.**

Cric, Wagenwinde, **jack.**

Cuir, Leder, **leather.**

Cuivre, Kupfer, **copper.**

Culasse, Cylinderdeckel, **cylinder-cover.**

Culotte d'admission, **induction valve cover or chamber.**

Curseur, Läufer, **index, slide-block.**

Cuve, Eimer, **tub.**

Cycle, Kreisprozess, **cycle.**

Cylindre, Cylinder, **cylinder.**

Débrayage, Ausrückvorrichtung, **disengaging gear.**

Décharge, Entladung, **discharge.**

Déchet, Schwinden, **waste, loss.**

Déclic, Auslösungsvorrichtung, Slipphaken, Drücker, **trip gear, catch, trigger.**

Découper, Durchschlagen, **to punch.**

Décrochage d'attelage, Ausrücken der Kuppelung, **disconnecting, disengaging, throwing out of gear.**

Dedans (en), innerhalb, **inside, within.**

Dégagement de vapeur, Dampfentwickelung, **production of steam.**

Dégauchi (-ie), vollkommen, **straight, flush.**

Dehors, ausserhalb, **out, outside.**

Démarrage, Anlassen, **start.**

Dent, hélicoïde, Zahn eines Schraubengetriebes, **tooth of a spiral wheel.**

Dent, Radzahn, **tooth.**

Dépense d'entretien, Beköstigung, Unterhaltungkosten, **expense of maintenance.**

Dérapage, Schlüpfung, **side slip.**

Dérayer, ein Rad aushemmen, **take the brake off a wheel.**

Désembrayer, ausrücken, entkuppeln, **to disengage, to disconnect.**

Dessous, unter, **under, below.**

Dessus, über, **over, above.**

Détente, Expansion, **expansion.**

Différentiel, Differentialgetriebe, **jack-in-the-box, balance gear.**

Direction, Steuergerät, **steering gear.**

Dispositif, Vorrichtung, **arrangement, device.**

Distance, Entfernung, **distance.**

Dos, Rücken, **back.**

Doucement, langsam, **slowly.**

Douille, Tülle, Hülse, **socket.**

Droit, recht, **right.**

Durée, Dauer, Fortdauer, **duration.**

Dynamomètre à ressort, Federdynamometer, **spring dynamometer.**

Eau d'injection, Einspritzwasser, **injection water.**

Ebullition (point d'), Siedepunkt, **boiling-point.**

Ecartement des essieux, *Empattement*, Entfernung der Achsen, **wheel-base.**

Echappement, Auspuff, **exhaust.**

Echarpe, Blattung, **scarf joint.**

Echelle, Leiter, **ladder, scale.**

Eclairage, Beleuchtung, **illumination.**

Eclisse, Lasche, Stossplatte, **fish-plate.**

Ecran, Schirm, **screen.**

Ecrou, Mutter, **nut.**

Ecuage (des roues), Ecuanteur, **dish (of the wheels).**

Effort de traction, Zugkraft, **draw-bar pull.**

Elancé, schlank, **thin, slender.**

Elever, errichten, **to erect, to raise.**

Email, Schmelzglas, **enamel.**

Emballer, wettlaufen, **to race.**

Embattage (de roue), beschienen, **tyreing.**

Emboîture du moyeu, Nabenloch, **axle-box.**

Embouchure, Mündung, **mouth.**
Embrayer, einkuppeln, **to throw in gear.**
Embrumé, neblig, **foggy, misty, hazy.**
Empattement, Radlinie, **wheel base.**
Enclanchement, Eindrucker, **locking gear.**
Encliquetage, Gesperre, Sperrvorrichtung, **pawl and ratchet gear.**
Encoche, Aussparung, **notch.**
Engorgement, Verstopfung, **obstruction.**
Engrenage conique, Kegel-Getriebe, **bevel gear.**
Engrenage droit, Stirnrad-Getriebe, **spur wheel.**
Engrenage, Zahnräder, **toothed gearing, cog wheels.**
Enrayer, hemmen, **to stop, to trig, to skid, to scotch (a wheel).**
Entaille, Schieberloch, **notch.**
Entrefer, Luftraum, **air gap.**
Entretien, Unterhaltung, **maintenance.**
Entretoise de châssis, Quersprosse, Querbalz, **cross-bar, cross-beam.**
Enveloppe, Bekleidung, **jacket, casing.**
Epaisseur, Stärke, **thickness, dimension.**
Epissure, Splissung, **splice.**
Epontille, Stütze, **stanchion.**
Epreuve, Probe, **trial proof, test.**
Escarbilles, Asche, **ashes, cinders.**
Escarondelle, Achsnagel, **pin, forelock.**
Esprit, Spiritus, **spirit.**
Essai, Probe, **trial, experiment.**
Essence, Essenz, **essence, spirit.**
Essieu, Achse, Welle, **axle.**
Essieu d'arrière, Hinterachse, **hind axle, rear axle.**
Essieu d'avant, Vorderachse **fore axle.**
Estampille, Fabrikstempel, **trade-mark.**
Estoquian, Sperrklinke, Drücker, **pawl.**
Etain, Zinn, **tin.**
Etalon, Normalmass, **standard.**
Etalonner, eichen, **to standarise.**
Etanche, dicht, **tight.**
Etape, tägliche Fahrt, **stage.**
Etau, Schraubstock, **vice.**
Etincelle, Funken, **spark.**
Etroit, schmal, **narrow.**
Evider, auskehlen, **to groove.**

Fabricant, Fabrikant, **manufacturer.**
Fanal, Laterne, **lantern.**
Fardier, öffene Güterwagen, Lastwagen, **truck, goods lorry.**
A Faux, falsch, verkehrt, **not properly, the wrong way.**
Fente, Spalte, **fissure.**
Fer, Eisen, **iron.**
Fer à angle, Winkeleisen, **angle iron.**
Fer à cheval, Hufeisen, **horse-shoe.**
Fer à T, T-Eisen, **T iron.**
Fer feuillard, Bandeisen, **hoop iron.**
Fer fondu, Gusseisen, **cast iron.**
Fil, Draht, **wire.**
Filet de vis, Schraubengewinde, **thread, worm of a screw.**
Filière, Schneidkluppen, **die, screw plate.**
Flasque, Seitenstück, **flitch plate.**
Flotteur, Schwimmer, **float.**
Fonte, Gussstück, **casting.**
Force centrifuge, Zentrifugalkraft, **centrifugal force.**
Force de traction, Zugkraft, **traction, tractive force.**
Force d'un ressort, Tragfähigkeit einer Feder, **strength of a spring.**
Foret, Bohrer, **drill.**
Fourche, Gabel, **fork.**
Fourgon, Packwagen, **baggage waggon.**
Fournaise, Ofen, **furnace.**
Fourneau d'une chaudière, Kesselfeuerung, **furnace of a boiler.**

Fourreau compensateur, Dehnungsstopfbüchse, **expansion joint.**
Fourrure, Futterrung, **fish, lining.**
Foyer, Feuerkasten, **fire box.**
Frais de camionnage, Rollgebühren, **porterage, cartage.**
Frais d'entretien, Unterhaltungskosten, **expenses of maintenance.**
Fraise, Fräse, **milling cutter.**
Fraiser, versenken, **to countersink.**
Frein, Bremse, **brake.**
Frein différentiel, automatische selbstthätige Bremse, **act-brake on differential.**
Frêne, Esche, **ash (wood).**
Frette, Nabenring, Reifen, **nave-hoop, shrunk collar.**
Frette de moyeu, äusserer Nabenring, **nave-hoop.**
Fringalage, Schlüpfung, **side slip.**
Frottement, Reibung, **friction.**
Frottement de roulement, rollende Reibung, **rolling friction.**
Fumée, Rauch, **smoke.**
Fuseau, Spindel, **spindle.**
Fusée, Achsschenkel, **axle-journal.**

Gabarit, Calibre, Schablone, **template.**
Galet, Rolle, **friction roller, pulley.**
Galopin, Handwagen, **hand-truck.**
Garde-crotte, Spritzrahmen, **splash board.**
Garde (plaque de), Schutzplatte, **horn plate.**
Gare, Station, **station.**
Garniture, étoupe, Packung, **packing (for glands).**
Garniture métallique, Metallpackung, **metallic packing.**
Genouillère, Kugelscharnier, **ball and socket joint.**
Glissement, Gleiten, Schlüpfung, **sliding, slipping.**
Gorge, Kehle, **throat.**
Gorge d'essieu, Achsenhals, **bearing neck of an axle or shaft.**
Goujon, Kupplungsbolzen, **coupling-bolt.**
Goupille, Bolzen, Stift, **pin, cotter.**
Goupiller, annageln, **to pin.**
Goutte, Tropfen, **drop.**
Goutte à goutte, tropfenweise, **drop by drop.**
Grain de butée, de crapaudine, Zapfenlagerpfanne, Stutzpfanne, **thrust plate of a step bearing.**
Graisser, schmälzen, **to oil.**
Graisseur, Schmiervorrichtung, **lubricator.**
Graisseur compte-gouttes, graisseur à gouttes visibles, **sight feed lubricator.**
Grêle, Hagel, **hail.**
Griffe (manchon à), Klaue, Kuppelung, **clutch.**
Grille, Gitterwerk, **grate, grating.**
Grippage, heisslaufen (das Lager), **seizing (bearings).**
Grue, Kran, **crane.**
Guide, Führung, **guides.**
Guipage, Überspinnung, **braiding, taping.**

Haie, Hecke, **hedge.**
Halage, Bugsieren, **towing, hauling.**
Halte, Haltepunkt, **station, stop.**
Haute pression, Hochdruck, **high pressure.**
Hélice, Schraube, **screw.**
Houille, Schwarzkohle, **coal.**
Huile, Öl, **oil.**
Huileur, syn. *graisseur.*

Ignition, Entzündung, **ignition.**
Imperméable, wasserdicht, **waterproof.**
Inclinaison, Steigungverhältnis, **slope, gradient.**
Incrustation, Kesselstein, **boiler scales.**
Indicateur de niveau d'eau, Wasserstandszeiger an Dampfkesseln Schauglas, **water gauge.**

Inducteur, Induktor, **inductor.**
Induit, Anker, **armature.**
Inertie, Trägheit, **inertia.**
Ingénieur, Ingenieur, **engineer.**
Injection, Einspritzung, **injection.**
Intensité, Stromstärke, **intensity (current).**
Interrupteur, Commutateur, Ausschalter, **switch.**
Inversion, Umkehrung, **reversal.**

Jante de roue, Felge, **felloe, rim.**
Jauge, Eichmass, Lehre, **gauge.**
Jet, **jet.**
Jeu des dents, Spielraum, **backlash (in gearing).**
Joint à la Cardan, Universalgelenk, Cardan, cardan'sche Gelenke, **double knuckle, or universal joint.**
Joint, Fuge, Verbindung, Gelenke, **joint, link.**
Joue, jumelle, Wangen, **cheek, flange.**

Lâcher, nachlassen, **to slacken, let go.**
Laisser, lassen, **to let.**
Laiton, Messing, **brass.**
Lame, Klinge, **blade.**
Lame d'eau dans les chaudières, Wasserwände, **water spaces in boilers.**
Lame de plomb, das Bleiblech, **lead-plate.**
Languette, Scheerzapfen, **feather, tongue.**
Léger, leicht, **light.**
Lest, Ballast, **ballast.**
Levier, Hebel, **lever.**
Levier de changement de marche, Umsteuerungshebel, **reversing gear, reversing lever.**
Lien, Band, **tie, strap.**
Ligature, Wickelbund, **binding joint.**
Lignite, Braunkohle, **brown-coal, lignite.**
Lime, Feile, **file.**
Limon, Schlamm, **mud, slime.**
Linguet, Sperre, **pawl.**
Lisse, glatt, **smooth.**
Locomotive routière, Strassenlokomotive, **road locomotive, road engine, traction engine.**
Longrine, longeron, Langschwelle, **longitudinal, frame plate, or sleeper.**
Longueur, Länge, **length.**
Longueur de course, Länge des Hubs, **length of stroke.**
Lourd temps, nebliges Wetter, **muggy, dull weather.**
Lumière, Licht, Loch, **light, hole, port.**
Lunette, Protzloch, **pintle-hole.**
Lunettes de chauffeur, Staubbrille, **goggles.**

Macadam, Kieselschag, **macadam.**
Mâchefer, Herdschlacke, **clinker, slag.**
Machine à tailler les roues, Räderschneidmaschine, **gear-cutting machine.**
Machine à vapeur, Dampfmaschine, **steam engine.**
Madrier, Bohle, **thick board or plank.**
Maillechort, Neusilber, **German silver.**
Maillon, Kettenglied, **link of a chain.**
Maniabilité, Lenksamkeit, Handlichkeit, **ease of management.**
Manomètre, Dampfdruckmesser, **steam gauge, water gauge, &c.**
Manche, Heft, **handle.**
Manchon d'accouplement, Kupplungsmuffe, **coupling box.**
Manchon (de brûleur), Brennerhülse, **burner mantle.**
Manchon d'embrayage et de désembrayage, Kupplung zum Ein- und Ausrücken, **clutch-coupling.**
Manchon mobile (régulateur), **sliding sleeve (governor's).**

Manette, Handhabe, **handle, lever.**
Manille, Schäkel, **shackle.**
Manivelle, Kurbel, **crank.**
Manivelle, Schlusselkurbel, **spanner, handle.**
Manivelle composée, mehrfache Doppelkurbel, **double crank.**
Manivelle de mise en marche, Anlassungskurbel, **starting handle.**
Marchepied, Stufe, **step.**
Marteau, Hammer, **hammer.**
Marteau à river, Döppel, **riveting hammer.**
Marteau de régulateur, Regulatorhammer, **governor hammer.**
Mastic, Kitt, **putty, cement.**
Matage, Stauchen, **upsetting.**
Matériel roulant, das rollende Material, **rolling stock.**
Mécanicien, Maschinenwärter, **mechanic, engine-driver.**
Mécanique d'enrayage, Schraubenbremse, **skidding gear, screw-brake.**
Mèche, Docht, **wick.**
Mèche (foret), Beissel, **boring bit.**
Mélange, Mischung, **mixture.**
Mentonnet, Daumen, **cam.**
Mettre en exploitation, in Betrieb setzen, **to set at work, to work.**
Mettre en mouvement, Maschine anlassen, **to start the engine.**
Mise en train, en marche, en route, Anlassgetriebe, **starting gear.**
Mise en train automatique, automatische Anlassvorrichtung, **self-starter.**
Montée d'une route, Steigung einer Strasse, **gradient of a road.**
Moraillon, Schliessblech, **hasp, cotter.**
Mouton de voiture, Docken, **coach standard.**
Mouvement accéléré, beschleunigte Bewegung, **increased motion.**
Moyeu, Hülse, **hub.**
Moyeu d'un volant, Hülse, **nave (of a fly wheel).**

Neige, Schnee, **snow.**
Nervure, Rippe, **rib.**
Niveau, Horizont, **level.**
Nœud, Knotenschlag, **knot, hitch.**
Noix (à griffes), Griff, Klaue, **toothed clutch.**
Noyau, boisseau, Hahnkegel, **plug of a cock.**
Noyau, Kern, **core (foundry).**
Noyer un clou, Nagel versenken, **to countersink.**
Nuage, Wolke, **cloud.**

Obstacle, das Hindernis, Widerstand, **impediment.**
Œil d'un boulon, Auge, **eye of a bolt.**
Omnibus, der Omnibuswagen, **omnibus.**
Onde, Welle, **wave.**
Organe, Vorrichtung, Theil, **part.**
Organeau, Ring, **ring.**
Orifice, Offnung, **orifice, nozzle.**
Orifice d'évacuation, Dampfaustrittskanal, Auspuffskanal, **exhaust port.**
Ornière, Gleis, Radspur, **rut, groove.**
Outillage, Einrichtung, **plant, tools.**

Palan, Zugwinde, **tackle (lifting).**
Palier, horizontale Strecke, Lager, **level, bearing.**
Palier à billes, Kugellager, **ball bearings.**
Palier à rouleaux, Wellenlager, **roller bearing.**
Palonnier, Schwengel eines Wagens, **swing bar.**
Panne, Unfall, **accident, break-down.**
Pannetons, Backen, **clamps.**
Paroi, Wand, **partition.**
Pas, Schraubengang, Theilung, **pitch.**
Passage, Strassenübergang, **crossing.**

Patin, Gleitbacken bei der Steuerkulisse, **sliding-block.**

Patinage, Schleifen, Schlüpfung, **slipping on greasy ground or rails.**

Patte, Flügel, **lug, hasp, bracket, fastening, ear.**

Pavé, Steinpflaster, **pavement.**

Pédale, Pedal, Trittbrett, **treadle.**

Pelle à coke, Kohlenschaufel, **fire-shovel.**

Pencher, anlehnen, **to incline.**

Pente, Neigung, **slope, declivity.**

Pentures, Aufhängungsbeschlag, **hinges.**

Perré, Sickergraben, **ditch.**

Pesée, Gewicht, **weighing.**

Petit cheval, Hülfsmaschine, **donkey engine.**

Pignon, Getriebe, **pinion.**

Pile électrique, galvanische Säule, **electric battery.**

Pile sèche, Trockenelement, **dry battery.**

Pile voltaïque, galvanische Batterie, **galvanic or electric battery.**

Pince monseigneur, Brechstange, **crowbar.**

Pinces, Drahtzange, **pliers, nippers.**

Piste, Hufschlag (in der Bahn), **track.**

Piste relevée, **banked track.**

Piston, Kolben, **piston.**

Plancher, Decke, Fussboden, **floor, flooring.**

Plaque de fondation, Fundamentplatte, **foundation plate, bed plate.**

Plomb, Blei, **lead.**

Poids brut, Bruttogewicht, **gross weight, dead weight.**

Poignée, Heft, Handhabe, **handle, lever.**

Point d'appui, Drehpunkt, **centre of motion, fulcrum.**

Pointeau, Spitzpunze, **centre-punch, needle (valve).**

Pompe à feu, à incendie, Feuerspritze, **fire engine.**

Pompe d'alimentation, Speisepumpe, **feed-pump.**

Pont, Brücke, **bridge.**

Porte de foyer, Feuerthür, **fire-box door.**

Portière, Kutschenschlag, **coach door.**

Pot d'échappement, Auspufftopf, **exhaust box.**

Poteau de pente, Gradientanzeiger, **gradient post.**

Poulie, Seilrolle, **pulley.**

Poussière, Staub, **dust, grit.**

Poutre, Balken, **girder, beam.**

Prendre à la remorque, am Seile ziehen, **to take in tow.**

Presse-étoupe, Stopfbüchse, **stuffing-box.**

Pression, Druck, **pressure.**

Primage, Spucken, **priming.**

Prise de courant, Ladekontakt, **wall plug, charging plug.**

Prise de vapeur, Dampfhahn, **steam valve.**

Profondeur, Tiefe, **depth.**

Robinet à trois voies, Dreiröhrighahn, **three-way cock.**

Robinet de purge, Durchblasehahn, **drain-cock, relief cock, blow-off cock.**

Radiateur, Wasserabkühler, **water cooler, radiator.**

Rainure, Auskehlung, **gutter groove.**

Rais, rayon, Speiche, **spoke.**

Rampe, Neigung, **slope, declivity.**

Rapport, raison, Verhältnis, **ratio, rate.**

Rayon, Halbmesser, **radius.**

Rayon d'une roue, Radarm, **spoke of a wheel.**

Rechange (pièces de), Reserveteile, **spare parts.**

Réchauffeur, Vorwärmer, **feed-water heater.**

Refoulement, Compression, Druck, **back stroke, forcing stroke.**

Refroidissement, Abkühlung, **cooling.**

Registre, **boiler screen,**

Réglage par papillon, étranglement, Drosselung, **throttling.**
Remise, Remise, **coach-house.**
Rendement, Leistungsfähigkeit, **efficiency.**
Renvoi du tiroir, Schiebersteuerung, **valve gear.**
Réservoir, Behälter, **tank.**
Ressort, Feder, **spring.**
Ringard, Feuerhaken, **poker.**
Robinet, Hahn, **cock, tap.**
Roder (un arbre), **to lap (a spindle).**
Roder (une valve), einreiben, **to grind (a valve).**
Rondelle, Unterlagscheibe, **washer.**
Roue, Rad, **wheel.**
Roue à chevrons, Pfeilzahnrad, Doppelschaubenrad, **double helical wheel.**
Roue à rochet, Sperrrad, **ratchet wheel.**
Roue d'angle, Kegelrad, **bevel wheel.**
Roue dentée, Zahnrad, Stirnrad, **cog wheel.**
Roue hélicoïde, Schraubenrad, **spiral wheel.**
Rouleau, die Walze, **roller.**
Route carrossable, chaussée, die Fahrstrasse, **carriage road, highway.**

Sabot de frein, Bremsklotz, **brake block or shoe.**
Saturation, Sättigung, **saturation.**
Scorie, Mâchefer, Schlacke, **slag.**
Secteur, Sektor, **quadrant.**
Segment de piston, Kolbenring, **piston ring.**
Serre-fil, Drahthalter, **connector.**
Serrer le frein, bremsen, **to brake.**
Serrure, Schloss, **lock.**
Siège d'une soupape, Ventilsitz, **seat or seating of a valve.**
Sifflet, Pfeife, **whistle.**
Silencieux, Damper, **silencer.**
Silex, Kiesel, **flint.**
Socle, Fussgestell. Grundplatte, **socket, bed-plate.**
Soupape, Ventil, **valve.**
Soupape à papillon, Drosselklappe, **throttle valve.**
Soupape de sûreté, Sicherheitsventil, **safety-valve.**
Soute à charbon, Kohlenbunker, **bunker.**
Surchauffeur, Überhitzer, **superheater.**

Tablier, Schürze, **apron.**
Talus, Böschung, **slope, embankment.**
Tambour, Trommel, **drum, wide pulley.**
Tambour de frein, Bremsescheiben, **brake drum.**
Tampon, Puffer, **buffer**; Stöpsel, **plug.**
Temps beau, schönes Wetter, **fine weather.**
Temps humide, feuchtes, nebliges Wetter, **damp weather, wet weather.**
Tendeur, Drahtspanner, **stretcher (wire. belt).**
Terrain, Erde, **ground, earth.**
Tige, Stange, **rod, spindle.**
Tirage, Zug, **draught, traction.**
Tirant, Zugstange, **stay, tie.**
Tirefond, Schraubenbolzen (für Schienen), Spitzbolzen, **coach screw.**
Tiroir, Schieber, **slide-valve.**
Toc, Mitnehmer, **dog, catch, driver.**
Tôle, Schwarzblech, **sheet-iron.**
Tourillon d'essieu, Achsschenkel, **axle journal, gudgeon.**
Tourillon d'une roue, Radzapfen, **spindle, pivot of a wheel.**
Tourne-à-gauche, Wendeeisen, **tap wrench.**
Tournevis, Schraubenzieher, **screw-driver.**
Traction, Zug, **traction.**
Train de dessous, Untergestell, **under-carriage.**

Train de dessus, Obergestell, **part of a carriage which is above the frame.**
Transmission, Übertragung, **gearing, transmission.**
Traverse, Querstück, **cross tie.**
Trémie, Rumpf, **funnel, hopper.**
Tropplein, Überfluss, **overflow.**
Trou, Loch, **hole.**
Tube, *tuyau*, Rohr, Schlauch, **tube, pipe.**
Tuyau de tropplein, Überflussrohr, **overflow pipe.**
Tuyauterie, Röhrenwerke, **piping.**

Usine, Fabrik, **works.**
Usure, Abnutzung, **wear and tear.**
Utile, nutzbar, **effective, useful.**

Vaporisateur, Verdunster, **sprayer, atomiser.**
Ventilateur, Ventilator, Kapselgebläse, **fan.**
Vérin, Hebelschraube, **screwjack.**
Verrou, Riegel, **bar bolt.**
Vidange, Reinigung, **blowing off.**
Vilebrequin, Drehbohrer, **hand brace.** See *Arbre.*
Virer, umwenden, **turn round.**
Vis, Schraube, **screw.**
Vis sans fin, Schraube, **worm.**
Vitesse, *Vélocité*, Geschwindigkeit, **speed, velocity.**
Voie (*des voitures*), Gleisbreite, **track.**
Voiture à courroie, Wagen mit Riemenbetriebe, **belt-driven car.**
Voiture à engrenages, Wagen mit Zahnradbetriebe, **gear-driven car.**
Voiture à vapeur, Dampfwagen, **steam waggon.**
Voiture de place, Droschke, **hackney.**
Voiture de remise, de louage, **carriage on hire.**
Volant, Schwungrad, **flywheel.**
Volant à main, Handrad, **hand wheel.**

ENGLISH—FRENCH—GERMAN

Acceleration, *accélération*, Beschleunigung.
Accelerator, *accélérateur*, Beschleuniger.
Accumulator, *accumulateur*, Akkumulator, Sammler.
Adhesion, *adhérence*, Adhäsion.
Advance, ignition, *avance à l'allumage*, Vorauszündung.
Ahead, forward, *en avant*, vorwärts.
Air gap, *entrefer*, Luftraum.
Alcohol, *alcool*, Alkohol.
Alloy, *alliage*, Legirung.
Apparatus, *appareil*, Apparat, Vorrichtung.
Apron, *tablier*, Schürze.
Armature, *induit*, Anker.
Arrangement (device), *dispositif*, Vorrichtung.
Asbestos, *amiante*, Asbest.
Ash (wood), *frêne*, Esche.
Ashes, cinders, *escarbilles*, *cendres*, Asche.
Ash pit, *cendrier*, Aschenkasten.
Astern, backward, *en arrière*, hinter.
Atomiser, *see* **Sprayer.**
Awl, *alène*, Ahle.
Axis, *axe*, Achslinie.
Axle, *essieu*, Achse, Welle.
Axle, fore, *essieu d'avant*, Vorderachse.
Axle, guard, horn plate, *plaque de garde*, Achsenblech.
Axle, journal or neck, *fusée*, *tourillon d'essieu*, Achsschenkel.
Axle or bearing, running hot of an, by friction, *chauffage d'un essieu ou d'un coussinet*, Warmlaufen einer Achse.
Axle or shaft, bearing neck of an, *gorge de l'essieu*, Achsenhals.

Axle, rear, *essieu d'arrière*, Hinterachse.

Axle-tree bolster, spring flap, *sellette d'essieu*, Achsschemel.

Back, *dos*, Rücken.

Backfire, *patage d'allumage*, Rückschlagen.

Backlash, *jeu des dents*, Spielraum.

Back stroke, *refoulement*, Druckhub.

Baggage waggon, *fourgon*, Packwagen.

Balance (spring), *dynamomètre à ressort*, Federwage.

Ball and socket joint, *genou à charnière, joint à boulet*, Kugelgelenk.

Ball bearings, *palier à billes*, Kugellager.

Ballast, *lest*, Ballast.

Banked track, *piste à virages relevés.*

Bar bolt, *verrou*, Riegel.

Battery (dry), *pile sèche*, Trockenelement.

Battery (primary), *pile*, Element (galvanisches).

Battery (secondary), *see* **Accumulator.**

Beam, *poutre, balancier*, Balken, Balancier.

Bearing (ball), *palier à billes, coussinet à billes*, Kugellager.

Bearing (plain), *palier (ordinaire)*, Lager.

Bearing (roller), *palier à rouleaux*, Wellenlager.

Bearing (self-oiling), *palier graisseur*, Lager mit selbstthäthiger Schmierung.

Bearing (seized), *palier grippé*, festgebundenes Lager.

Bearing (swivel), *palier à rotule*, gelenkige Lager.

Bearing (thrust), *palier de bûtée*, Stutzlager.

Belt (endless strap), *courroie sans fin*, Laufriemen.

Bent, *courbé*, gebogen.

Bevel wheel, bevel gear, *roue d'angle, engrenage conique*, Kegelgetriebe.

Binding joint, *ligature*, Wickelbund.

Blade, *lame*, Klinge.

Blow-off (cock), *vidange (robinet)*, Reinigung (Hahn).

Boiler flues, *carneaux de chaudière*, Feuerzugesse.

Boiler scales, *incrustations*, Kesselstein.

Boilers, water spaces in, *lame d'eau dans les chaudières*, Wasserwände.

Boiling-point, *point d'ébullition*, Siedepunkt.

Bolt and nut, *boulon et écrou*, Schraubbolzen und Mutter.

Bolt, holding down, *boulon de fondation*, Befestigungschraube.

Bore, *alésage*, Ausdrehung.

Boring, *alésage*, Nachbohren.

Boring bit, *mèche, foret*, Beissel, Bohrer.

Braiding, taping, *guipage*, Überspinnung.

Brake, *frein*, Bremse.

Brake-block, or shoe, *sabot de frein*, Bremsklotz.

Brake-handle, *levier de frein*, Bremshebel.

Brake, to, *freiner, serrer le frein*, bremsen.

Brake on differential, self-acting, *frein différentiel, automatique*, automatische, selbstthätige Bremse.

Brake shaft, *arbre de frein*, Bremswelle.

Brass, *laiton*, Messing.

Braze, to, *braser*, hartlöthen.

Bridge, bridge piece, *pont, bride*, Brücke.

Broom, *balai*, Bürste.

Brown-coal, *lignite*, Braunkohle.

Bucket, tub, *baille, baquet, cuve*, Eimer.

Buckling, *gauchissage.*

Buffer, *tampon*, Puffer.

Bunker, *soute à charbon*, Kohlenbunken.
Burn, to, *brûler*, verbrennen.
Burner, candle, *brûleur, bec, bougie*, Brenner.
Bush-bearing, *palier à douille*, Lager.

Cam, lifter, *came, mentonnet*, Daumen.
Cam-shaft, *arbre à came*, Daumenwelle.
Can, *bidon, burette*, Kanne, Dose.
Cap (axle), *chapeau de moyeu*, Achsenkappe.
Cap (bearing), *chapeau de palier*.
Capsize, to, *chavirer* (*nautical*), umkippen.
Carburettor, *carburateur*, Vergaser.
Carriage road, *chaussée, route carrossable*, Fahrstrasse.
Carriage work, *carrosserie*, Wagenwerk.
Casing, *carter*, Gehäuse.
Cast iron, *fer fondu, fonte*, Gusseisen.
Casting, *fonte*, Gussstück.
Caulking, *calfatage*, Kalfatern.
Cell (container), *bac* (*d'accumulateur*), Gefäss.
Cell (element of a battery), *élément*, Zelle.
Centre of motion, fulcrum, *point d'appui*, Drehpunkt.
Chain, coupling, *chaîne d'attelage*.
Chain link, *maillon*, Kettenschlussglied.
Chainless, *acatène*, kettenlos.
Change speed, *changement de vitesse*, Geschwindigkeitsänderung.
Channel or groove, *coulisse, rainure*, Falz.
Charcoal, *charbon de bois*, Holzkohle.
Charge, *charge*, Ladung.
Cheeks, *jumelles, joues*, Wangen.
Chest, box, *caisse*, Kasten.
Chimney, funnel, *cheminée*, Schornstein, Rauchfang.
Chisel, *ciseau*, Stechbeitel, Meissel.
Circuit-breaker, *coupe-circuit*, Ausschalter.
Clamps, *pannetons*, Backen.
Clinker, *mâchefer*, Herdschlacke.
Cloud, *nuage*, Wolke.
Clutch, *cône de friction*, Klaue.
Clutch, *cône d'embrayage et de débrayage*, Kupplung.
Coach-door, *portière*, Kutschenschlag.
Coach-house, *remise*, Remise.
Coach-screw, *tirefond*, Schraubenbolz für Schienen, Spitzbolzen.
Coach-standard, *mouton de voiture*, Docken.
Coach - wrench (monkey - wrench), shifting spanner, *clef anglaise*, Universalschraubenschlüssel.
Coal, *houille*, Schwarzkohle.
Cock, tap, *robinet*, Hahn.
Coil, *bobine*, Spule.
Collar, *collier, frette, collet*, Hülse.
Commutator (dynamo), *collecteur*, Kollector.
Commutator (switch), *commutateur*, Stromwender, Umschalter.
Cone, *noyau, cône*, Conus.
Connecting-rod, *bielle*, Kurbelstange.
Connector, *serre-fil*, Drahthalter.
Cooling, *refroidissement*, Abkühlung.
Copper, *cuivre*, Kupfer.
Cotter, *see* **Pin.**
Counter, meter, *compteur*, Messapparat.
Countersink, to, *fraiser, noyer un clou*, versenken, einen Nageversenken.
Counter-weight, balance, *contrepoids*, Gegengewicht.
Coupling bolt, *goujon*, Kupplungsbolzen.
Coupling box, *manchon d'accouplement*, Kupplungsmuffe.
Cracked, *fêlé*, rissig.
Crane, *grue*, Kran.
Crank, *arbre de manivelle*, Kurbel.

Crank shaft, *arbre de vilebrequin*, Kurbelwelle.
Crank web, *bras*, Arm.
Cross-bar, cross-beam, *entretoise*, Quersprosse, Querbalz.
Cross-head block, slide-block, *patin*, Gleitklotz.
Crossing, *carrefour*, Kreuzweg.
Crowbar, *pince*, Brechstange.
Cut, to, *couper*, schneiden.
Cutter, *fraise*, Fräse.
Cycle, *cycle*, Kreisprozess (mech.)
Cylinder, *cylindre*, Cylinder.
Cylinder cover, *culasse*, Cylinderdeckel.

Damage, *avarie*, Havarie.
Damp weather, wet weather, *temps humide*, feuchtes, nasses Wetter.
Damper, dash pot, *amortisseur*, Dampfungsvorrichtung.
Depression, diminution, *abaissement*, Niedrigung.
Depth, *profondeur*, Tiefe.
Devil, sprag, *béquille*, Hemmenstange.
Dial, *cadran*, Zifferblatt.
Differential, Jack in the box or balance gear, *différentiel*, Differenzialgetriebe.
Discharge, *décharge*, Entladung.
Disconnecting, disengaging, throwing out of gear, *débrayage*, Ausrücken der Kuppelung.
Disengage (to), to disconnect, *débrayer*, ausrücken.
Disengaging apparatus, *déclic*, Auslösungsvorrichtung, Slipphaken.
Disengaging gear, *débrayage*, Aus- oder Entkupplung.
Dish (of a wheel), *écuage*, Ecuanteur.
Distance, *distance*, Entfernung.
Ditch, *fossé*, Sickergraben.
Donkey engine, *petit cheval*, Hülfsmaschine.

Drain-cock, relief-cock, *robinet de purge*, Durchblasehahn.
Draught. traction, *attelage, tirage*, Bespannung, Zug.
Drawbar pull, tractive effort, *effort de traction*, Zugkraft.
Drift punch, *poinçon*, Durchschlag.
Drill, *foret, perçoir*, Bohrer.
Driver, dog, *toc*, Mitnehmer.
Driving axle or shaft, *axe, arbre ou essieu moteur*, Treibachse.
Drum (armature or wide pulley), *tambour*, Trommel.
Duration, *durée*, Dauer, Fortdauer.
Dust, grit, *poussière*, Staub.

Easily, slowly, *doucement, lentement*, langsam.
Eccentric rod, *tige d'eccentrique*, Excentrikstange.
Edge, *bord, arête*, Kante.
Effective, useful, *utile*, nutzbar.
Efficiency, *rendement*, Leistungsfähigkeit.
Elbow, *coude*, Krummer.
Electric battery, *pile électrique*, galvanische Säule, Zelle.
Enamel, *émail*, Schmelzglas.
End, butt, *about*, Stoss.
Engine, to start the, *mettre en marche, démarrer*, Maschine anlassen.
Erect, to, to raise, *élever*, errichten.
Escape of steam, *dégagement de vapeur*, Dampfentweichung.
Essence, spirit, *essence*, Essenz.
Exhaust-port, *orifice d'évacuation*, Dampfaustrittskanal, Auspuffskanal.
Expansion, *expansion*, Detente.
Expansion gear, *appareil de détente, mécanisme de détente*, Expansions-Steuerung.
Expansion joint, *joint compensateur*, Dehnungstopfbüchse.
Expense of maintenance, or cost of working, *frais d'entretien*, Unterhaltungskosten.

Eye of a bolt, *œil d'un boulon*, Auge.

Fan, *ventilateur*, Gebläse.

Feather, *clavette noyée*, Rippe, versenkte Keile.

Feed apparatus, *appareil d'alimentation*, Zufuhr der Wasserzuleitung.

Feed-pump, *pompe d'alimentation*, Speisepumpe.

Felly, felloe, *jante de roue*, Felge.

File, *lime*, Feile.

Fine weather, *beau temps*, schönes Wetter.

Fire-box, *foyer*, *boîte à feu*, Feuerkasten, Feuerung.

Fire-box door, *porte de foyer*, Feuerthür.

Fire-engine, *pompe à feu*, *à incendie*, Feuerspritze.

Fire-shovel, *pelle à coke*, Kohlenschaufel.

Firing, *ignition*, *allumage*, Zündung.

Fissure, *fente*, Spalte.

Fish, lining, *fourrure*, Futterung.

Flange, *bride*, Verbindung.

Flaw, *paille*, *fêlure*, Riss.

Flint, *silex*, Kiesel.

Flitch plate, *flasque*, Seitenstock.

Float, *flotteur*, Schwimmer.

Float gauge, *indicateur à flotteur*, Schwimmerlehre.

Flue, *carneau*, Feuercanalesse.

Fly-wheel, *volant*, Schwungrad.

Foggy, misty, hazy, *embrumé*, neblig.

Fork, *fourche*, Gabel, Gabelstange

Foundation plate, base plate, *plaque de fondation*, Grundplatte.

Fracture, *cassure*, Bruch.

Frame, *cadre*, *châssis*, Rahmen, Fassung, Gestell.

Frame plate, *longeron*, *longrine*, Längenstück des Rahmens.

Friction, *frottement*, Reibung.

Friction (rolling), *frottement de roulement*, rollende Reibung.

Friction roller, pulley, *galet*, *rouleau*, Reibungsrolle.

Full speed, to run at, *lancer à toute vitesse*, (einen Zug) mit voller Geschwindigkeit ablassen.

Funnel, *entonnoir*, *trémie*, Rumpf.

Furnace, *fournaise*, *fourneau*, Ofen.

Furnace of a boiler, *foyer d'une chaudière*, Kesselherd.

Galvanic or electric battery, *pile voltaïque*, galvanische Säule oder Zelle.

Gauge, gage, *jauge*, *calibre*, Eichmass, Lehre.

Gear, *engrenage*, *mécanisme*, Getriebe.

- **Bevel gear,** *engrenage cônique*, Kegelräder.
- **Spin gear,** *engrenage droit*, Stirnräder.
- **Worm gear,** *engrenage à vis sans fin*, Schraubengetriebe.

Gear box, *boîte à engrenages*, *c rter*, Zahnrädergehäuse.

Gear (reversing), *marche arrière*, Umsteuerung.

- **Differential,** *différentiel*, Differenzialgetriebe.
- **Running gear,** *châssis avec roues de transmission*, Untergestellt.

Girder, beam, *poutre*, Balken.

Goggles, *lunettes de chauffeur*, Staubbrille.

Goose-neck, *col de cygne*, Schwanenhals.

Gradient of a road, *pente d'une route*, Steigung eines Weges.

Gradient-post, *poteau de pente*, Gradientanzeiger.

Grate, grating, *grille*, Gitterwerk.

Grease, axle-grease, *graisse à voitures*, Achsenschmiere.

Groove, *rainure*, *creux*, Auskehlung.

Groove, to, *évider*, aushöhlen.

Gross weight, dead weight, *poids brut*, Bruttogewicht.

Ground, earth, *terrain*, Erde.

Gudgeons, *goujon*, Rudersteven.
Guides, crosshead guides, *guide, glissière*, Führung.

Hail, *grêle*, Hagel.
Hammer, *marteau*, Hammer.
Hand-brace, *vilbrequin*, Drehbohrer.
Handle, *manette, manche, manivelle*, Handhabe, Heft, Stiel.
Hasp, *moraillon*, Schliessblech.
Heater (feed-water), *réchauffeur*, Vorwärmer.
Hedge, *haie*, Hecke.
High pressure, *haute pression*, Hochdruck.
Highway, *chaussée, route carrossable*, Kunststrasse.
Hinge, *charnière*, Thürband, Scharnier.
Hole, *orifice, trou*, Loch.
Hollow, depth, *creux*, Hohlkehle.
Hood, *capote*, Verdeck.
Hopper, *trémie*, Rumpf.
Hotwell, *baille (du condenseur)*, heisse Brunnen.

Ignition, *ignition, allumage*, Entzündung.
Impact, collision, *choc*, Stoss.
Impediment on the line, *obstacle sur la route*, Hindernis.
Inductor, *inducteur*, Induktor.
Inertia, *inertie*, Trägheit.
Injection, *injection*, Einspritzung.
Inside, within, *en dedans*, innerhalb.
Intake, suction, *aspiration, admission*, Ansaugen.
Iron, *fer*, Eisen.
Iron, angle, *cornière, fer à angle*, Winkeleisen.
Iron, hoop, *fer feuillard*, Bandeisen.
Iron, T, *fer à T*, T-Eisen.
Iron sheeting, *blindage en fer*, Eisenblech.

Jack (rack), *cric*, Wagenwinde.
Jack (screw), *vérin*, Schraubenwinde, Hebelschraube.
Jack in the box, *différentiel*, Differential-Getriebe.
Jacket, *chemise, enveloppe*, Mantel.
Jamming, *coincement*, Festdrückung.
Jet, *jet*.
Joint, *articulation*, Fuge, Gelenke.
Joint, *joint, assemblage*, Verbindung.
Joint, butt, *couvrejoint*, Stossfuge.
Joint, seam, *rapport*, Naht.
Joint (universal) or swivel joint, *joint universel, joint à la Cardan*, Cardan'sche Gelenke.

Key of a lock, *clef*, Schlüssel.
Key or feather, *clavette*, Kiel.
Key, wedge, *cale*, Unterlage.
Knot, *nœud*, Knoten, Schlag.
Knuckle (double), *joint universel, cardan*, Universalgelenke.

Ladder, *échelle*, Leiter.
Lantern, *fanal, lanterne*, Laterne.
Lashing, fastening, *amarrage*, Sorring.
Lead, *plomb*, Blei.
Lead, white, *blanc de céruse*, Bleiweiss.
Leather, *cuir*, Leder.
Length, *longueur*, Länge.
Level, *niveau, palier*, Horizont.
Lever, *levier, manette*, Hebel.
Light, *lumière*, Licht.
Light, empty, *léger*, leicht.
Lighting, ignition, *éclairage, allumage*, Beleuchtung, Zündung.
Linchpin, cotter, *goupille*, Splint, Splissnagel.
Link of a chain, *maillon*, Kettenglied.
Load, *charge*, Belastung.
Loading or laden, *chargement*, Belastung.
Lock, *serrure*, Schloss.

Locking-ring, *bague*, Stossring.
Loop, *boucle*, Schleife.
Low pressure, *basse pression* Niederdruck.
Lower, to, *abaisser*, niedriger machen.
Lower a road, to, *abaisser une route*, eine Strasse tieferlegen.
Lubricator, *lubricateur, graisseur*, Schmiervorrichtung.

Macadam, *macadam*, Kieselschlag.
Maintenance, *entretien*, Unterhaltung.
Manufacturer, *fabricant*, Fabrikant.
Mixture, *mélange*, Mischung.
Mouth, *embouchure*, Mündung.
Mud, *boue*, Schlamm.
Muggy, dull weather, *temps lourd*, nebliges Wetter.

Nail, *clou*, Nagel.
Narrow, *étroit*, schmal.
Nave, end of the, *bout du moyeu*, Nabenende.
Nave-hole, *emboîture du moyeu*, Nabenloch.
Nave-hoop, *frette de roue*, äusserer Nabenring.
Neck, collar, *collet*, Rand.
Needle, pricker, *aiguille, épinglette*, Nadel.
Noise, *bruit*, Geräusch.
Not properly, the wrong way, *à faux*, falsch.
Notch, *encoche*, Aussparung.
Nozzle, *ajutage, buse*, Duse, Wetterloch.
Nut, *écrou*, Mutter.
Nut (lock), *contre-écrou*, Gegenmutter.

Obstruction, *engorgement*, Verstöpfung.
Oil, *huile*, Ol.
Oil, to, *huiler, graisser*, schmälzen.
Omnibus, *omnibus*, Omnibuswagen.
Orifice, *bouche*, Öffnung.
Orifice, nozzle, *orifice*, Öffnung.
Out, outside, *dehors*, ausserhalb.
Outfit, *outillage, matériel*, Ausstattung.
Over, above, *dessus*, über.
Overflow, *trop-plein*, Überfluss.

Pack, to, *emballer*, verpacken.
Packing for glands, *garniture, étoupe*, Packung.
Packing, metallic, *garniture métallique*, Metallpackung.
Pad, *tampon*, Schale.
Paddle-wheel, *roue à aubes*, Schaufel.
Part, *partie, organe, pièce*, Theil, Vorrichtung.
Partition, *paroi, cloison*, Wand.
Paving stone, *pavé*, Pflaster.
Pawl, *estoquian, linguet*, Sperrklinke.
Pin, cotter, *goupille, goujon*, Stift, Bolzen.
Pin, forelock, *escarondelle, cheville ouvrière*, Achsnagel.
Pin, split, *goupille fendue*, Splint, Splissnagel.
Pin, tommy, *broche*, Dorn.
Pinion, *pignon*, Getriebe.
Pintle-hole, *lunette*, Protzloch.
Piston-ring, *segment de piston*, Kolbenring.
Piston-rod, cross-head of the, *crosse de piston*, Querhaupt der Kolben.
Piston stroke, *course du piston*, Kolbenhub.
Pitch, *bitume, asphalte*, Pech.
Pitch, *pas d'une vis*, Steigung eines Schraubenganges.
Pitch-chain, *chaîne à la Vaucanson*, Vaucanson'sche Kette.
Pitch circle, *cercle primitif*, Theilkreis.
Plant, *outillage*, Betriebsanlage.
Plate (horn), *plaque de garde*, Schutzplatte.
Plate (fish), *éclisse*, Lasche, Stossplatte.

Platform, *perron, estrade, plate-forme*, Perron.

Pliers, nippers, *pinces*, Die Drahtzange.

Plug, *bouchon*, Pflock, Stöpfer.

Plug of a cock, *noyau, boisseau*, Hahnkegel.

Plug, sparking, *bougie d'allumage*, Zündkerze.

Poker, *tisonnier, fourgon*, Feuerhaken.

Porterage, cartage, *frais de camionnage*, Rollgebühren.

Pressure, *pression*, Druck.

Pulley, *poulie*, Seilrolle.

Punch, *poinçon*, Stampfe.

Punch, to, *découper, poinçonner*, Durchschlagen.

Putty, cement, *mastic*, Kitt.

Rack, *crémaillère*, Zahnstange.

Radiator, *radiateur*, Radiator für Abkühlung des Circulationswassers.

Radius, *rayon*, Halbmesser.

Railway, railroad, *chemin de fer, voie ferrée*, Eisenbahn.

Ratio, rate, *rapport*, Verhältnis.

Reamer, *alésoir*, Nachräumer.

Rear or hind part, *arrière-corps*, Hinterflügel.

Resistance coil, *bobine de résistance*, Widerstandsspule.

Reversal, *inversion*, Umkehrung.

Reversing lever, reversing handle, *levier de changement de marche, levier de marche en arrière*, Umsteuerungshebel.

Right, *droit*, gerade, recht.

Ring, band, hoop, *anneau, organeau*, Ring.

Road locomotive, road engine, traction engine, *locomotive routière*, Strassenlokomotive.

Rod, *tige*, Stange.

Roller, *galet, rouleau*, Walze.

Rolling stock, *matériel roulant*, rollendes Material.

Rope, *cable, cordage, corde*, Seil, Tau.

Running hot of an axle or a bearing by friction, seizing, *chauffage d'un essieu ou d'un coussinet*, Warmlaufen einer Achse.

Rut, groove, *ornière*, Radspur, Gleiss.

Safety valve, *soupape de sûreté*, Sicherheitsventil.

Saturation, *saturation*, Sättigung.

Scale (boiler), *incrustation*, Kesselstein.

Scarf, joint, *écharpe*, Blattung.

Screen, *écran, registre*, Schirm.

Screw, *hélice, vis*, Schraube.

Screw, worm of a, thread, *filet de vis, pas de vis*, Schraubengewinde.

Screwbolt, *boulon fileté*, Schraubenbolzen.

Screw-jack, *vérin*, Hebelschraube, Wagenwinde.

Seizing (bearings), *grippage (paliers, tourillons)*, Heisslaufen (Lager oder Schalen- und Zapfen).

Shackle, *manille*, Schäkel.

Shaft, axletree, *arbre*, Welle.

Sheet-iron, *tôle*, Schwarzblech.

Short (circuit), *court circuit*, Kurzschluss.

Side, *côté*, Seite.

Silencer, *silencieux*, Dämpfer.

Silver (German), *maillechort*, Neusilber.

Skidding, or scotching a wheel, *enrayage*, Hemmung.

Slacken, to, *lâcher, ralentir*, nachlassen.

Slide valve, *tiroir*, Schieber.

Slide valve chest, *boîte à tiroir*, Schieberkasten.

Sliding block, *patin*, Gleitbacken.

Slipping, side slip, *dérapage, patinage*, Schlüpfung, Schlüpfrigkeit.

Slope, declivity, *pente*, Hang, Neigung.

Slope, embankment, *talus*, Böschung.

Sloping, inclining, *penchant, incliné*, abhängig.

Smoke, *fumée*, Rauch.
Smooth, *lisse*, glatt.
Snow, *neige*, Schnee.
Socket, *douille*, Tülle, Hülse.
Spanner, *clef*, Schlüssel.
Spark, *étincelle*, Funken.
Speed, pace, *allure*, Gang.
Speed lever, *levier de changement de vitesse*, Schnelligkeitshebel.
Spindle, *broche, fuseau*, Spindel.
Spindle, pivot of a wheel, *tourillon d'une roue*, Radzapfen.
Spirit, *esprit*, Spiritus.
Splash board, *garde-crotte*, Spritzrahmen.
Splice, *épissure*, Splissung.
Spoke, *rais*, Speiche; *rayon d'une roue*, Radarm.
Sprayer, atomiser, *vaporisateur*, Verdunster.
Spring, *ressort*, Feder.
Spring, strength of a, *force d'un ressort*, Tragfähigkeit einer Feder.
Spring-balance, *peson à ressort*, Federwage.
Sprocket-wheel, *couronne, roue à chaîne*, Kettenrad.
Spur-wheel, *engrenage droit*, Stirnradgetriebe.
Square, *carré*, Quadrat.
Stage, *étape*, tägliche Fahrt.
Stanchion, *épontille*, Stütze.
Standard, *étalon*, Normalmass.
Starting, *démarrage*, in Gang setzen, anlassen.
tarting gear, *mise en train, mise en marche*, Anlassgetriebe.
Station, *gare, halte*, die Station, Haltestelle, Bahnhof.
Steam boiler, boiler-maker, *chaudière, chaudronnier*, Dampfkessel, Kesselmacher.
Steam engine, *machine à vapeur*, Dampfmaschine.
Steam gauge, *manomètre*, Dampfspannungsmesser.
Steam valve, *prise de vapeur*, Dampfhahn.
Steam waggon, *voiture à vapeur*, Dampfwagen.
Steel, *acier*, Stahl.
Steel, cast, *acier fondu*, Gussstahl.
Steel, mild, *acier doux*, weicher Stahl.
Steering gear, *direction*, Steuerung, Steuergerät.
Step, *marche, marchepied*, Stufe.
Stephenson's link motion, *coulisse de Stephenson*, Stephenson'sche Coulissensteuerung.
Stop, to, *enrayer*, hemmen.
Straight, flush, *affleuré*, vollkommen.
Strap, *courroie*, Riemen.
Strengthening-pieces, *fourrure, contrefort*, Verbandstücke.
Stretcher (belt), *tendeur*, Drahtspanner.
Stroke, length of, *longueur de course*, Länge des Hubs.
Stuffing-box, *boîte à garniture*, Stopfbüchse.
Stuffing-box, gland of a, *presse-étoupe*, Stopfbüchsendeckel.
Switch, *interrupteur, commutateur*, Schalter.

Take in tow, to, *prendre à la remorque*, am Seile ziehen.
Tank, *bâche, réservoir*, Behälter.
Tap, *see* **Cock,** *robinet*, Hahn.
Tape, *ruban*, Band.
Tarpaulin, *bâche*, Teertuch.
Templet, *gabarit, calibre*, Lehre.
Terminal binding screw, *borne*, Drahtklemme.
Thickness (dimension), *épaisseur*, Stärke.
Thin, slender, *élancé*, schlank.
Throat, *gorge*, Kehle.
Throttle, *papillon*, Drosselklappe.
Throw in gear, to, *embrayer*, einkuppeln.
Throw over, to, *jeter par-dessus bord*, über Bord werfen.
Tie, *lien*, Band.
Tight, *étanche*, dicht.
Timber, *bois de construction*, Holz, Bauholz.

Timber, work or framing, *charpente*, Zimmerwerk.
Tin, *étain*, Zinn.
Tommy, *see* **Pin.**
Tooth, *dent*, Radzahn.
Torque, *couple*, Drehmoment.
Towing, hauling, *halage*, Bugsieren, Schleppen.
Towing line, rope, *remorque*, Schlepptau.
Track, *piste, voie des voitures*, Gleisbreite.
Traction, tractive force, *force de traction*, Zugkraft.
Trade-mark, *estampille, marque de fabrique*, Fabrikstempel.
Transmission, *transmission*, Ubertragung.
Tread (of a **waggon**), *voie*, Tritt, Schritt, Lauffläche eines Rades.
Trial, experiment, *essai*, Probe.
Trial proof, test, *épreuve*, Probe.
Trip gear, Trigger, *détente, déclic*, Drücker, Gesperre.
Truck, goods waggon, *fardier*, Lastwagen, Plateauwagen.
Tube, *tube, tuyau*, Rohr.
Tyre, *bandage*, der Radreif.
Tyre on a wheel, to put the, *embatter une roue*, ein Rad beschlagen.

Unbolt, to, *débarrer*, ausriegeln.
Under, below, *dessous*, unter.
Under-frame, *châssis*, Untergestell.

Valve, *soupape*, Ventil.
Valve, clack, *clapet*, Klappe.
Valve gear, valve motion, *renvoi de tiroir*, Schiebersteuerung.
Valve (reducing), *détendeur*, Expansionsschieber.
Valve-rod, *tige du tiroir*, Schieberstange.
Valve, seat or seating of a, *siège d'une soupape*, Ventilsitz.

Vane, leaf, tooth, *aile*, Flügel.
Vice, *étau*, Schraubstock.

Waggon, heavy four-wheeled lorry, *camion*, Frachtwagen.
Washer, *rondelle*, Unterlagscheibe.
Waste, loss, *déchet*, Schwinden.
Water gauge, *indicateur de niveau d'eau*, Wasserstandszeiger an Dampfkesseln, Pagel.
Waterproof, *impermeable*, wasserdicht.
Water-tank, *réservoir à eau, caisse à eau, bâche, baille*, Wassertank.
Way, road, *chemin*, Weg, Strasse.
Wear and tear, *usure*, Abnutzung.
Wedge, *coin*, Keil.
Weight, *pesée, poids*, Gewicht.
Wheel, *roue*, Rad.
Wheel-base, *écartement des essieux, empattement*, Entfernung der Achsen.
Wheel-cutting engine, *machine à tailler les engrenages*, Räderschneidmaschine.
Wheel, fore, *roue de devant*, Vorderrad.
Wheel, rear, *roue de derrière*, Hinterrad.
Wheels, to relieve the, *décharger les roues*, Räder entlasten.
Wheelwork, toothed ; cog-wheels, *engrenage, roue dentée*, Zahnräderwerk.
Whistle, *sifflet*, Pfeife.
Wick, *mèche*, Docht.
Wing, flange, *ailette*, Zapfen.
Wire, *fil*, Draht.
Wood, timber, *bois*, Holz.
Work, at, *en activité*, im Betriebe.
Works, *usine*, Fabrik.
Workshop, factory, *atelier*, Atelier, Fabrik.

Yoke, *culasse* (*dynamo*), Joch.

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